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NTIPP FLEET SURVEY OF TECHNICAL MANUAL USERS.(U)
JAN 78 J E CONNELL, D W GATER, J J GOLDBERG N00600-76-C-1352
UNCLASSIFIED FR77-12-1138 NL

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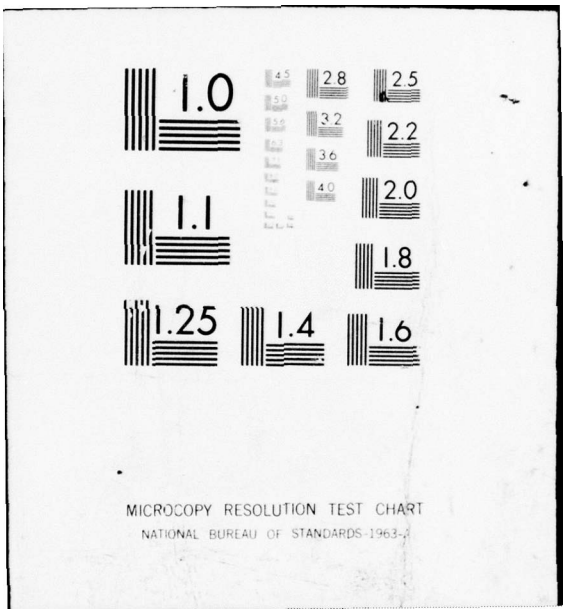
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NTIPP FLEET SURVEY OF
MANUAL USER

APPROVED FOR PUBLIC RELEASE; DISTRI

Submitted by
NTIP Project, Hughes-Ful
to
David W. Taylor Naval Ship R&D Ce

Contract N00600-76-C-135
16 January 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This special report documents the NTIPP Fleet Survey of MOTD Users, conducted between 22 October 1976 and 31 December 1976, under the provisions of the above-cited contract number.

The approach to the survey included a structured questionnaire and direct interview of technician-level MOTD users. The survey involved a total of 427 respondents.

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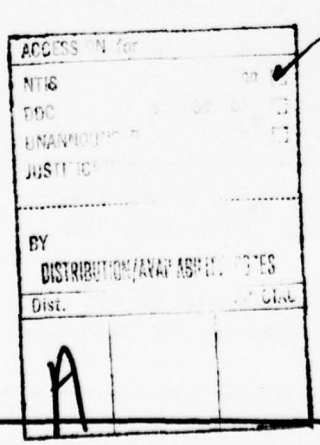
Item 19. Key Words (Continued)

Maintenance Dependency Chart (MDC)
Media
Microform (microfilm or microfiche)
Navy Technical Information Presentation Program (NTIPP)
Planned Maintenance System (PMS)
Reading Grade Level (RGL)
Ships Selected Records
Spares System
Systems and Feasibility Tradeoff Analyses (SFTOA)
Technical Manual (TM)
Update

Item 20. Abstract (Continued)

A reasonable stratification of respondents was employed, within the constraints of schedule, cost, and availability of ships and technicians. The survey was limited to shipboard and shore-based elements of the Pacific Fleet.

It should be noted that the problems reported herein are based on stated user preferences and as such should be subjected to further analysis and cost effectiveness studies prior to implementation actions. However, the survey provides valuable input from the user community to the overall NTIPP effort.



NTIPP FLEET SURVEY OF TECHNICAL MANUAL USERS

Submitted to

David W. Taylor

Naval Ship R&D Center (Code 1803)

In Accordance With

Contract No. N00600-76-C-1352

by

Hughes Aircraft Company
Ground Systems Group
Fullerton, California

16 January 1978
FR 77-12-1138

ACKNOWLEDGMENTS

Appreciation is gratefully extended to the shipboard and shore-based elements of the U.S. Navy's Pacific Fleet, without whose assistance this Fleet Survey of MOTD Users would not have been possible. The interest and warm cooperation shown by officers and enlisted personnel alike have resulted in breadth and depth of coverage far beyond that originally envisioned at the inception of this survey.

While it is not practical to list here all of the contacts made during the survey, specific thanks are offered to the NTIPP Project Office at the David W. Taylor Naval Research and Development Center for direction and assistance in scheduling, to the ships and shore-based installations cited in Topic 2.4, Conduct of the Survey, and to the various Navy agencies and officers whose coordination enabled the necessary contacts and visits to be made.

FOREWARD

Hughes Ground Systems Group is pleased to submit this Fleet Survey Report to the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), Bethesda, Maryland in accordance with Contract N00600-76-C-1352 for the Navy Technical Information Presentation Program (NTIPP). This contract is under the technical management of Mr. S.C. Rainey and Mr. J. J. Fuller, both of DTNSRDC, Code 1803.

Performing organization personnel who participated in the Fleet Survey effort and in the preparation of this report include the following individuals:

J. E. Connell
D. W. Gater
J. J. Goldberg
C. W. Jackson
V. L. Kefauver
A. Laicato
H. E. LeBlanc
C. E. Marvin
H. A. McDougal
N. S. Merlo
M. M. Porta
G. L. Sietsema
V. C. Westgate

SECTION S
EXECUTIVE SUMMARY

1. PROBLEM ADDRESSED BY THE SURVEY

The NTIPP Fleet Survey was undertaken in order to obtain concise, definitive statements of maintenance and operation technical data (MOTD) problems from the point of view of the MOTD user in the fleet.

The Navy Technical Information Presentation Program (NTIPP) is a research and development effort whose overall purpose is to improve the effectiveness of technical manuals used for maintenance. It has resulted from recognition of long-standing deficiencies in MOTD, and represents a concerted effort to correct them. The Program differs from previous attempts at such improvement in that it emphasizes an optimized match between the user and his data, and takes a unified approach to the entire technical manual preparation and use cycle, rather than merely applying a different format, presentation technique, or publication medium.

Although NTIPP comprises comprehensive research in all aspects of MOTD, it was believed by the NTIP Program Office that the effort would not be complete without a comprehensive, current, and first-hand survey of the MOTD users. The NTIPP Program Office thus tasked Hughes to implement the survey.

MOTD problems and deficiencies have been frequently reported in publications of various types, but review of these publications by the NTIPP staff prior to this fleet survey disclosed three relevant concerns. First, the problem statements did not originate directly from the MOTD user – the maintenance technician in his working environment. Second, the published data seldom treated the problems in specific and quantifiable forms. Third, previous surveys often focused on a specific user element, rather than the broad community of Navy MOTD users.

The NTIPP fleet survey sought to obtain a definition of each significant problem in clear, concise terms such that the problem could be analyzed, evaluated, and corrective action recommended. This list of problems was to be obtained from the users in the Fleet and Training activities by the survey team at the user work stations, allowing the problems to be addressed in terms of:

- Probable causes based on responses and observations
- Impact on the individual user and the Navy as stated by the respondents and observed by the survey team
- The magnitude (cost in terms of morale, manpower and budget) as seen by the users and observed by the survey team.

The survey and the problems addressed were rigorously managed to obtain data which faithfully present the MOTD users point of view.

Use of the Term MOTD – Within the context of this report the term "MOTD" (Maintenance/Operator Technical Data) is used in the generic sense to apply to any of three aspects of technical manual development: technical data, technical information, and the technical manual per se. Technical data refers to the raw engineering data which is generated on the system/equipment being procured. This data is subsequently converted into technical information which is normally conveyed to the user via the technical manual. It is important to note here that "technical manual" refers not only to book-type TMs, but includes any vehicle for conveying the technical information (viz. microform, motion picture, audio tape, etc.).

Finally, it should be emphasized that the term MOTD applies to material which is employed by a system/equipment operator or maintenance technician, or which is used during training.

2. APPROACH AND CONDUCT OF THE SURVEY

The NTIPP fleet survey took the questions directly to the user in his normal working environment. The survey was conducted at selected Pacific Fleet facilities, seeking the widest possible spectrum of user types and environments available.

Examinations of previous surveys were performed in selecting an optimum approach for the NTIPP Fleet Survey. None of those examined suited the overall purpose of this survey. The NTIPP Fleet Survey was directed to specific problem areas such as media used, format desired for electronics manuals, compatibility with work space available, etc. A prime point of consideration was to insure that the results obtained were directly representative of the user.

The selected approach consisted of developing a complete, easily comprehended questionnaire to be administered in a direct-structured interview with the MOTD user at his duty station. The questionnaire was written for easy comprehension by all users, even those with limited reading abilities. Question sequence and wording was carefully considered to prevent leading the interviewee into a biased response. The direct-structured interview technique was constantly refined during the survey, finally resulting in one-on-two interviews which lasted approximately two hours each.

The survey was conducted at Pacific Fleet activities from November 1 through December 22. (See Topic 2.4 for a detailed schedule.) The survey team was welcomed and received excellent cooperation from the various activities. At each activity visited, the initial approach was to request interviewees that represented the widest possible selection of ratings with a variety of experience levels. These requests produced the wide spectrum of users being sought. A summary of activities visited by the survey team includes:

- Aircraft training activities – Navy and Marine Corps – representing new, in-service and old aircraft types.
- Two shipyards – one for discussions with Civil Service personnel, the other to visit the crew on an aircraft carrier undergoing overhaul.
- A U.S. Air Force aircraft maintenance unit.
- A Type Command staff.
- Ship types consisting of aircraft carrier, helicopter ship, submarine tender, older type destroyer, fast-frigates, destroyer tender, guided-missile cruiser, nuclear submarine, and new-type destroyer.
- Mobile Technical Unit.
- Fleet Maintenance Advisory Group.
- Ship Selected Records control activity and contractor.
- Propulsion Examining Board.

A total of more than 400 Navy rated personnel were interviewed. It is felt that the breadth and comprehensiveness of the survey is sufficient to produce results that are valid and usable as a reference source for future NTIPP efforts.

3. PRINCIPAL FINDINGS OF THE SURVEY

The NTIPP Fleet Survey found MOTD-related problems that have a major impact on the Navy's ability to perform assigned missions. The impact is felt in manpower utilization, morale, and in equipment/system readiness rates.

The NTIPP Fleet Survey found that the MOTD user has various problems that adversely affect his ability to perform. The man in the fleet is well aware of these problems, and often stated that improvement of MOTD will result in large improvements in his performance and provide measurable benefits to mission performance.

This user awareness was reflected in another area. The average sailor is very aware of costs. This cost-consciousness was notable in the frequency with which it occurred. The man in the fleet wants to see cost-effective solutions that would result in improved overall performance.

The awareness of MOTD problems was not used as an excuse for poor performance. Rather, there were numerous instances where the problems are masked by the excellent dedication and performance of the user in spite of poor support for MOTD. The following is a summary of the more significant MOTD problems.

- The medium selected for MOTD presentation is often a problem rather than an aid as intended. Microform in particular is generally disliked because it is often difficult to use in the working environment, and because of the poor reliability of the reader/printers.
- The environment and the MOTD are often mismatched. Such things as large books in small spaces, fragile books in dirty areas, small print type in dark areas, and other similar problems exist.
- MOTD is not well-matched to the users skill-level and/or his job situation.
- MOTD is used extensively in both formal and informal training, but has to be supplemented heavily to be usable as a training document.
- MOTD is often not kept up-to-date. The equipment/system configuration is different that the data supporting it.
- The user feedback system is often not responsive, and thus is not used enough to be effective.
- The preventive/periodic maintenance system is working well, but the MOTD is not keeping pace. The format and content need up-grading for new MOTD and updating for existing MOTD.
- MOTD for shipyard-designed equipment is often inadequate or totally lacking.
- The spares and spare part number system is causing extensive wastes in manpower utilization. The system wastes money, time, and creates morale problems with trained maintenance men. The ship's mission performance capabilities are impaired by problems with the spares system.

Detailed descriptions and analyses of these and other problems and resulting conclusions are found in the body of the report.

4. CONCLUSIONS AND RECOMMENDATIONS

The NTIPP Fleet Survey team concluded that the MOTD problems reported to the users can be solved individually and collectively using a mixture of existing and new methods and technologies that will produce measureable, cost-effective benefits to the individual user and to the Navy. The recommendations are to optimize the organization and management of available techniques and resources.

The conclusions reached by the NTIPP Fleet Survey Team are that most MOTD problems can be resolved using a mixture of currently available and new techniques and technologies. The effort will require close evaluation of individual problems, while maintaining the perspective of the user-viewpoint. The basic solution appears to lie in the development of an effective, responsive MOTD acquisition organization that exerts strict management over the MOTD-generation community. The following is a summary listing of conclusions and recommendations.

- The impact of media on MOTD users is large. New media applications need a strict, in-field test and evaluation by, and for, the user. The resultant effectiveness of the user must be the prime criteria in making the final judgment of usability and effectiveness.
- Maintainers and operators require MOTD that is usable in the work station environment. Consideration of environmental factors must be a determinant in the generation of MOTD. The MOTD should be field-tested in the working environment by a typical user.
- In many instances the MOTD does not match the user's skills and job situations. In some cases, the user's skill exceeds the level of coverage provided. In other cases, the MOTD is beyond his comprehension level. The MOTD is often not suitable for the user's actual job situation. The MOTD must be produced to match both the skill level of the user and the job which he performs.
- The MOTD user has needs and preferences, which are not addressed in much current MOTD. The user's needs and preferences should be evaluated and matched by the MOTD format, coverage, and media. The user community must be considered in definable groups, and responded to by group, rather than attempting to match some hypothetical, universal user. The three groupings, which recur in this report, should not be interpreted as the "definable" groups. The definable groups will be derived from future NTIPP studies.
- The MOTD is used in formal and informal training situations as the prime data source. Inadequate consideration of this function of MOTD is apparent. The training task should be considered and attended to by integrating skilled, experienced trainers into the MOTD generation function.
- The MOTD update system is slow and unreliable. MOTD update should be subjected to strict management, particularly for MOTD generated by shipyards. The update for new MOTD should be defined and managed as a warranty item for a specified period of time.
- The MOTD user feedback system is not sufficiently responsive. The feedback system needs strict management, with response times specified. New MOTD feedback should be a part of the warranty clause, and requires response to the originator of inputs. Existing MOTD feedback should also require a quick response to the originator of the input.

- MOTD is used to produce Planned Maintenance System (PMS) Maintenance Requirement Cards (MRCs). The PMS-MRC system is performing well. The MOTD used to generate MRCs is not always accurate or current; this requires MRCs to be corrected over a period of time, using feedback. The MOTD preventive maintenance data should receive more attention and input from the user community during the generation phase.

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SECTION 1
INTRODUCTION

1.1 OBJECTIVES OF THE SURVEY

The overall objective of the NTIPP Fleet Survey of MOTD Users was to establish a data base of user-perceived MOTD problems, with consideration given to training implications and the environment in which the MOTD is used. Recommendations drawn from this data base will benefit both the NTIP Program and other Navy activities outside the purview of NTIPP.

The intent of the survey was to provide a more definitive data base of user-perceived MOTD problems than had resulted from previous efforts, and to draw conclusions and recommendations for MOTD improvements. To this end, the following concerns must be addressed:

User Emphasis – To assure the highest quality of opinions involving MOTD problems and potential improvements it is necessary to identify, and orient the survey toward, the ultimate users of MOTD. The ultimate user group was defined in this survey as consisting of shipboard and shore-based technicians who use MOTD in their preventive and corrective maintenance tasks, and shore-based instructors who use MOTD as primary or secondary training aids.

Environmental Consideration - To interpret survey respondents' maintenance environment it is important that the survey inquiries address pertinent aspects of that environment, and that the survey itself take place within the respondents' usual environment for first-hand observation by personnel conducting the survey.

Training Consideration - To assess the degree of MOTD usefulness in training situations, it is necessary not only to include appropriate training-related inquireies in the survey but also to assure that training personnel comprise part of the survey sample.

Usefulness of Survey Results - The primary purpose of conclusions and recommendations in this report is to guide the several research activities within the ongoing NTIPP effort. However, it is also recognized that the survey may produce findings whose treatment and implementation fall outside the scope of NTIPP. In such cases, these findings will be documented, and conclusions and recommendations drawn, for the benefit of the appropriate Navy agency having jurisdiction over the problem cited and its proposed remedies.

Use of the Term MOTD - Within the context of this report the term "MOTD" (Maintenance/Operator Technical Data) is used in the generic sense to apply to any of three aspects of technical manual development: technical data, technical information, and the technical manual per se. Technical data refers to the raw engineering data which is generated on the system/equipment being procured. This data is subsequently converted into technical information which is normally conveyed to the user via the technical manual. It is important to note here that "technical manual" refers not only to book-type TMs, but includes any vehicle for conveying the technical information (viz. microform, motion picture, audio tape, etc.)

Finally, it should be emphasized that the term MOTD applies to material which is employed by a system/equipment operator or maintenance technican, or which is used during training.

1.2 PROBLEM STATEMENT AND BACKGROUND

The NTIPP Fleet Survey effort was designed to augment other surveys conducted relative to the fleet user community, thereby gaining the maximum in useful data within the schedule and budget constraints. Advantage was taken of previous HAC surveys.

A number of surveys regarding technical manual usage in the US Navy have been conducted in the past. Many of these surveys were highly focused to address a specific problem or system/equipment. As a program, NTIPP appears to be first to view Navy technical manuals across the entire spectrum. Difficulties were encountered in identifying the past surveys, as most are either not reduced to report form, or the reports are not formally submitted for distribution.

Although NTIPP has a very broad scope, budget constraints required that care be exercised in formulating a survey of fleet users. It was essential that this survey avoid unnecessary duplication of other efforts, and further that significant insight be gained into the actual problems of the user community. Historically, a number of organizations internal to Hughes provided some feedback to the "technical manual" community. For the most part, these organizations represent the view of the field service representatives who support HAC equipments/systems worldwide. Other feedback on TM utility is provided by the technical training organization. These types of "user views" are important, but it must be recognized that they do not represent a valid cross-section of Navy-wide users. The primary focus of this prior data is from the Navy user community responsible for the support of systems similar to those produced by HAC, namely electronic equipment/systems. Such a formal survey was conducted in 1975 by the Field Engineering Department at Hughes, Fullerton. Its questionnaire is documented in Appendix D. The NTIPP survey was deliberately oriented to focus somewhat more intensely on that segment of the user community responsible for equipments/systems that lie outside of the HAC product line.

Additional constraints to the NTIPP Fleet Survey related to time and schedule. Approval of this survey effort was received on 21 October 1976 with the report planned for 24 December 1976. The survey activity was restricted to the Pacific Fleet with the majority of the fleet interviews occurring on ships ported in San Diego, and was expected to be completed 1 December 1976. The reception of the Survey team in the fleet was enthusiastic. The average interview had been planned to take about 45 minutes with a planned 200 to 225 interviews. In reality interviews ran about 90 to 120 minutes per interview, and the number of interviewees exceeded 425. Additional manpower was required, and the fleet survey activity was finally cut off on 22 December (three weeks late); the amount of data collected exceeded the original planned by a factor of 3 to 4.

1.3 SCOPE AND APPROACH

The scope of the NTIPP Fleet Survey of MOTD Users was originally intended to involve some five man-months of effort over a two-month period, but this effort was more than doubled due to on-site interview needs. The overall approach was based on minimizing interference with Navy routine and subjective bias in the responses.

Resources and Schedule Allocation – The survey was planned in September 1976, under the authority and direction of the NTIPP Project Office at the David Taylor Naval Ship Research and Development Center (DTNSRDC). The total survey effort, including the development of the questionnaire and schedule, the conduct of on-site and shipboard interviews, and the subsequent analysis and documentation efforts, was originally scoped as a two-month effort by a survey staff of two or three individuals from the contractor's NTIPP staff. However, the survey scope escalated rapidly after on-site interviews began, as a result of two unexpected developments.

First, the individual respondents offered extensive comments about their MOTD problems and preferences while answering the survey inquiries, and interviews were found to consume approximately two hours each, compared with the one hour anticipated. Second, the shore-based activities and ships (particularly the latter) were not only willing, but insistent in their acceptance of the survey team, often requesting that the onboard survey effort be extended to accommodate more interviews.

As a result, the interview schedule was lengthened from a period of two weeks to nearly two months with DTNSRDC approval, and additional personnel were assigned from the contractor's research staff to meet the expanded requirements. Topics 1.4, Limitations, and 2.4, Conduct of Survey Activities, discuss the impact and the implementation details of this escalation in scope.

Geographical Scope – Survey operations were limited to the Pacific Fleet area by direction of the NTIPP Project Office at DTNSRDC in the interests of schedule and budget. No firm plans exist at present to subsequently expand this scope to include elements of the Atlantic Fleet; such decision (if any) will await evaluation of this report by specialists from the Atlantic Fleet.

Minimization of Interference – An important element in the overall approach to the survey was the need to minimize interference with normal Navy routine. This was accomplished through careful schedule coordination with responsible officers on each vessel and at each shore-based facility, after prior planning and approval from higher-level authorities. In this regard, extensive use was made of message traffic by the NTIPP Project Office at DTNSRDC, in preparing the way for subsequent direct contact with individual ships and facilities.

Minimization of Subjective Biases – Two types of biases are traditionally encountered in any survey – those of the interviewer, and those of the respondent. In the NTIPP Fleet Survey, a previously prepared questionnaire was used for all interviews, thereby reducing interviewer biases and standardizing the context of responses. The principal devices used to minimize bias by the respondent were cross-check inquiries in the questionnaire and probings by the interviewers in ambiguous areas to determine respondent motivation.

More details on the questionnaire and interview approach are given in Section 2, Methodology, of this report. Also included in Section 2 is a further discussion of survey conduct.

1.4 LIMITATIONS

Several circumstances involving schedule, funding, and fleet availability limited this NTIPP Fleet Survey. However, the most pressing limitation at this juncture is that relating to the limited time available for thorough and thoughtful analysis.

The conduct of a fleet survey of technical manual usage problems had been under consideration for some time by the NTIPP Project Office at DTNSRDC. The basic reasons for not conducting a survey earlier in the NTIP Program centered around the concern of interference with routine fleet activities. Hence, it had not been planned to conduct such a survey as part of Phase I SFTOA effort; however, in dealing with MOTD problems, the necessity of directly addressing the "How do you know?" issue became the overriding factor.

The significant limitations impacting the NTIPP Fleet Survey and this report include schedule and staffing considerations, sample size and stratification factors, questionnaire inadequacies, subjectivity and biases typical of a survey, and scoping limitations on the analysis of survey results. These are discussed in the following paragraphs.

Schedule and Staffing Limitations – As seen in Figure 1-1, the planned schedule for the NTIPP Fleet Survey was a 60-day effort, beginning shortly before the October 1976 In-Process Review, and culminating in a survey report on 4 December 1976. A staff of three individuals from the contractor's NTIPP research team was assigned to perform the planned effort. However, due to the fleet response to the survey team, the scope of the effort escalated sharply and saturated all available remedies in terms of schedule and staff adjustments. (See Figure 1-2, Actual Schedule.)

Far from being regarded as interferers in ships' routine, the NTIPP Fleet Survey team was welcomed by the fleet so overwhelmingly that additional manpower and time were required to accomplish the effort to a reasonable level. Individual interviews consumed twice the anticipated time due to extensive comments by interviewees; on several occasions, ship command personnel strongly requested the survey team to lengthen its on-board duration for additional coverage. Recognizing that strong emphasis must be placed on the quality of the survey output, schedule provisions were augmented and additional personnel were shifted to the survey effort from the contractor's NTIPP research force. Even with these increases in survey time and resources, maximizing the efforts of the survey team was barely able to cope with the unforeseen demand. It was apparent that the survey was constrained by limits in available funding and schedule, and the results documented herein are regarded as the best obtainable within those constraints.

Sample Size and Stratification Factors – Although the survey used a sample size large enough to sustain the confidence level usually employed in surveys (see Topic 2.3 of this report), the stratification was less than ideal due to practical limitations in budget and approach. First, in the interests of budget and schedule constraints, the survey was limited to elements of the Pacific Fleet by direction of the NTIPP Project Office at DTNSRDC. The impact of this limitation (i.e., the existence of potential differences between the Pacific Fleet and the balance of the Navy) is not known at this time. Second, the cross-section of technician ratings sought by the survey team was slightly modified to place emphasis on mission-critical systems in the case of aircraft carriers. (See Topic 2.3.) This modest departure from ideal stratification is felt to be in the Navy's best interest, as it focuses attention on MOTD associated with the more important equipments.

1.4 LIMITATIONS (Continued)

Questionnaire Limitations – Since the questionnaire was designed for interviews of limited duration, it was restricted to those areas felt in advance to be of the most concern to the users of MOTD. However, this survey questionnaire (prepared and printed in advance of technician interviews) did not accommodate certain unforeseen but significant interests on the part of the interviewees. For example, the subjects of Ships Selected Records and data problems involving the spares system were extensively commented upon, although not addressed by specific inquiries in the questionnaire. Responses in such areas were documented as interviewers' notes to the best ability of the survey team, and are reported herein.

Behavior Subjectivity – While the biases of the interviewers can be largely eliminated through construction of a structured questionnaire, the subjective biases of the interviewees are another matter. In brief, it is often quite difficult to determine the actual complaints of the user community. Frequently the sailor/technician would tell an interviewer what he (the sailor) thought the interviewer wanted to hear. The real value of the guided interview technique was evident in this situation, by allowing a more intensive probing.

For instance, the initial reactions of the fleet users regarding microform were almost totally negative, yet further probing uncovered the view that microform would be excellent for parts lists. It was also noticed that in some cases sailor/technicians had filled out the interview forms before the interview, only to change their responses during the conduct of the interview. Another instance of the difficulty in uncovering fleet realities was encountered when a sailor/technician had stated that he (a) wanted standard size 8-1/2 x 11 manuals and (b) preferred the use of flow charts in troubleshooting. The interviewer then asked to see some examples of the TMs that this sailor/technician utilized every day in the actual working environments. In this location, a locker of TMs was opened up and the interviewer noticed two volumes of flow diagrams as part of the TM complement. When asked about the utility of these flow diagrams, the sailor/technician stated that he "...never uses them." Additionally, the sailor/technician pulled out a 7" x 9" volume and stated that this was his best TM, contained the most useful data, and was the "best size." Thus the same sailor/technician stated that he (a) preferred flow charts for trouble-shooting and later stated he did not use them, and (b) wanted 8 1/2 x 11 inch size manuals, but actually preferred the 7 x 9 inch size. For these reasons the reader is urged, when reading the topics in Sections 3 and 4, to carefully consider the human variations that often exist.

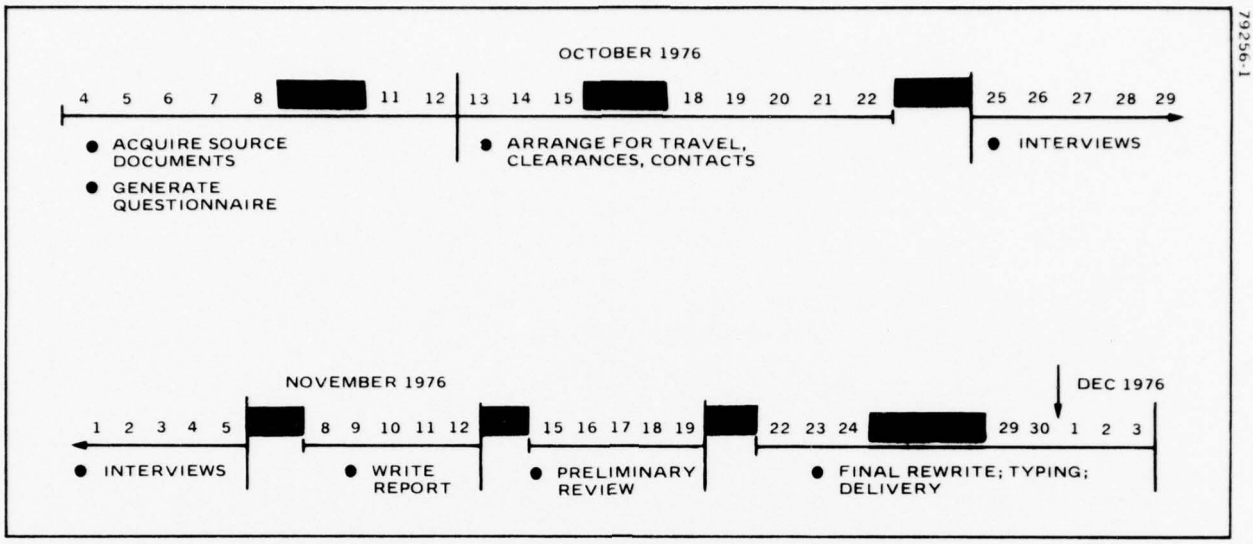

Figure 1-1. Planned Schedule of Survey Events. The survey was originally conceived as a 60-day effort involving two to three NTIPP research personnel.

	NOVEMBER 1976					DECEMBER 1976				
	1 — 5	8 — 12	15 — 19	22 — 26	29 — 3	6 — 10	13 — 17	20 — 24		
WHIDBEY ISLAND-NAS	XX									
PUGET SOUND — SHYD	X									
EL TORO — USMCAS	XX									
NORTON — AFB		X								
USS CONSTLLLATION		XXXX	XX	X						
MIRAMAR — NAS			XXX							
COMNAVAIRPAC			X							
USS TRIPOLI			XX							
USS SPERRY				XXX						
USS AGERHOLD				X						
USS BRADLEY				X						
USS GRAY					XX					
USS AJAX					XXX					
USS JOUETT						XX				
CDR BUCHBERGER						X				
DATC — FMAG						X				
FLEET TRAINING CENTER						XX	XX			
ROSENBLATT & SONS						X				
USS POLLACK							XXX			
MOTU — 5							XX			
PEB — PACIFIC							X			
SUPSHIPS							X			
USS KINKAID								XX		

THANKSGIVING

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Figure 1-2. Actual NTIPP Survey Schedule. The planned 2-week interview period was enlarged to nearly two months, with analysis and report preparation occurring in early 1977.

SECTION 2
METHODOLOGY

2.1 RESEARCH METHODS CONSIDERED AND SELECTED

The survey employed direct interviews of Navy technicians who are regarded as the ultimate or "real" users of technical manuals. The advantages of this approach over alternatives such as literature searches, direct evaluation of MOTD, and surveys of other MOTD-knowledgeable individuals far outweigh its higher cost.

Fundamental to any meaningful survey of technical manual problems is the choice of respondents for such a survey. If, for example, it is desired to measure the perception of MOTD problems by knowledgeable specialists who are well-acquainted with MOTD preparation and use, it would be sufficient to survey the key officers and civilians within the Navy technical manual community, or to employ the expertise of NTIPP researchers in analyzing the faults and virtues of a cross-section of existing technical manuals.

However, to survey any but the ultimate technical data users – the shipboard or shore-based maintenance and operations technicians, and shore-based instructors – would bias the survey, since those respondents would not be constrained by the personnel characteristics or the "real-world" usage environment of technical data. Thus, the initial methodological step in planning the survey was to define the "real user" of technical data as the shipboard operator, the shipboard or shore-based maintenance technician, and the shore-based instructor, and to orient the survey to that real user. Moreover, it is important that such a survey take into account not only the real user, but the environment in which he utilizes the technical data.

This realization sharply limits the alternatives otherwise available as research methods to be employed in a survey. In Table 2-1, the five potential alternative research methods are arranged in ascending order of relative cost. The second and third alternatives in the table were eliminated, on the grounds of lacking the viewpoint and environmental factors of the real user. The NTIPP research staff and Navy technical data specialists represent an inadequate model of the real user, due to their variation in perceptual capabilities as compared with the user and their lack of environmental constraints which confront real-world use of technical data.

The literature search alternative, though attractive from an economic basis, also poses serious deficiencies. The validity of this approach was investigated through examination of a number of previous surveys of technical manual problems. In the judgment of NTIPP researchers, these past surveys employed insufficient or undemonstrated utilization of real-user respondents, were lacking in sample size and/or stratification to be considered a reasonable cross-section of the users, and often incorporated questioning/inquiry methods designed primarily for machine processing of responses without sufficient regard for respondent understanding of the questions or response options. As a result, this alternative was rejected.

After deciding to survey real-user respondents in their normal operating environments, two more alternatives presented themselves – distributing questionnaires (by mail or drop-off) for completion by technicians and return without the benefit of face-to-face interviews, and direct interviews of the same respondents by NTIPP personnel, using the same questionnaire. It is quite apparent that the distribution-collection technique would exhibit a lower per-questionnaire cost; however, the disadvantages of this approach outweigh the cost benefits.

First, the voluntary nature of questionnaire completion and return tends to bias the survey in favor of those who are most able and willing to take the trouble, i.e., the more motivated and likely the better educated and trained

TABLE 2-1. COMPARISON OF RESEARCH METHOD ALTERNATIVES

Research Method Alternative	Relative Cost	Reflect Real-User Viewpoint	Reflect Real Environment	Remarks
Literature Search (fresh analysis of previous surveys) by NTIPP research personnel	Lowest	Varies, depending on survey	No	Previous surveys exhibit questionable inquiry methods, sample sizes, and choices of respondents
Evaluation of Cross-Section of TMs by NTIPP Researchers	Moderate	No	No	Adequate cross-section difficult to obtain – evaluation biased due to inherent capabilities of research personnel
Survey of Knowledgeable Officers and Civilians in Navy TM Community	Moderate to High	No	No	Absence of real-user limitations and environments; viewpoint based on provision and management rather than use
Survey of Real-User Respondents in Real Environments with Questionnaire, but Without Interviews	Moderate to High	Yes	Yes	Voluntary responses bias survey in favor of better motivated users; respondents have potential difficulty in perceiving intent of questions; no opportunity to probe and pursue responses
Survey of Real-User Respondents in Real Environments with Questionnaire and Direct Interviews	High	Yes	Yes	Greatest promise of reliable responses; minimizes subjectivity and respondent bias; can also produce response factors unanticipated when producing the questionnaire

technician. This would tend to downgrade any problems being experienced by technicians in the lower motivation areas. Second, the potential difficulties in understanding the intended meaning of the questions exist for any self-administered test. This approach does not sufficiently account for the need to pursue responses of interest, to pursue those responses not anticipated, and to probe into the motivating causes and reasons. Finally, such an approach does not allow the interviewer to evaluate the responses with respect to the interviewee's environment. Conducting personal interviews, with questionnaires administered and annotated by experienced NTIPP researchers, resolved these deficiencies. As a result, the latter technique was adopted in spite of its higher cost, to benefit from the higher quality of responses. Accordingly, plans were drawn up to assemble a reasonable sample of real-user respondents for interviews, within constraints of ship availability and non-interference with ship's routine. (Further details of ships and activities visited, and of sample size and stratification, are given in Topics 2.3 and 2.4 of this section.)

While principal reliance was placed on the direct-interview method, the "drop-off questionnaire" technique was also employed sparingly, as a test of its effectiveness and validity. A limited number of questionnaires was distributed to technicians for their completion and return; after completion, these questionnaires were then compared with similar responses from direct interview of the same rating and from the same shop. In addition, some of the self-interview respondents were subsequently subjected to direct interview to determine significant differences, if any, between their earlier and subsequent responses. It was found from these test cases that the potential difficulty in understanding the meaning of the questions was substantiated, and that responses from even the most qualified technicians tended to be far more insightful when elicited in direct interview.

To support the selected approach of direct interview of technicians, the questionnaire was developed on a semi-structured basis – that is, sufficiently structured to steer the interviewer's sequence of inquiry, yet flexible enough to permit probings, clarifications, and amplifications of selected responses. It was intended to cover all known or suspected technical manual problem areas, while also providing a broad framework which could accommodate any responses, even if outside the purview of the previously known or suspected areas. The questionnaire is described in more detail in Topic 2.2 of this section, and is reproduced in its entirety as Appendix C to this report.

2.2 SURVEY QUESTIONNAIRE DESCRIPTION AND RATIONALE

The questionnaire employed in the survey contained 72 inquiry items, and was organized into question groups of increasing complexity to enhance interviewee reactions Intentional overlap existed in areas of suspected controversial inquiry (e.g., media choices) as a cross-check mechanism to minimize bias and subjectivity.

The questionnaire contained 49 questions, some of which were further divided into separate parts, yielding a total of 72 inquiry items. The questionnaire was structured into five major areas, each of which sought specific information as indicated in Table 2-2. The full questionnaire is included as Appendix C.

A typical interview consumed about two hours. Some interviews used a one-on-one technique, while the majority were accomplished with one interviewer and two or more simultaneous interviewees. In the multiple-interviewee cases, separation of each interviewee's answer was recorded by the interviewer during the session. The one-on-two technique proved to be the most effective and beneficial from the viewpoint of control of the interview and value of answers.

In structuring the questions, the multiple-choice format was mixed with the essay-type question, to encourage responses from the interviewees which contained both fact and opinion. This afforded wider-ranging responses at the expense of easier use of machine-processing techniques.

Areas of inquiry were chosen with the intent of coinciding with known or suspected problem/complaint issues in technical manuals. The array of questions in the questionnaire was also intended to provide a framework for eliciting any and all comments of job-related interest, whether they fell in the known/suspected areas or not. (This was borne out in practice; the "general questions" category was responsible for several responses not directly addressed in any of the questions, but of significance to the survey and to this report.)

The sequence of the five major areas in the questionnaire was intentional. Interviewees were started off with "easy answer" categories (personal data, excluding names, and equipment description areas) before inquiring into more substantial questions, and ending with the most difficult items – the overall evaluations in the "general questions" category. This enabled interviewees to build up interest in the subject area before being confronted with the more complex questions.

It should be noted that overlap exists in areas of inquiry among the major areas shown in the table. This, too, was intentional. Options regarding physical factors, media choices, and preferences in visuals were recorded in the "general questions" area as well as in preceding areas, though from different viewpoints. This served to cross-check stated preferences and opinions, thereby making it possible to evaluate bias and subjectivity in those response areas.

The flexibility of the questionnaire enabled NTIPP interviewers to probe and clarify responses at any point, while maintaining an orderly sequence in inquiry. Comments were encouraged from the interviewees, over and above the specific questions at hand, and comments so volunteered were often entered as annotations on the questionnaire form. These additional comments serve to add depth to the survey, and gain improved insight into motivating causes and reasons for the opinions offered.

TABLE 2-2. PURPOSE AND INTENT OF MAJOR AREAS IN QUESTIONNAIRE*

Major Area of Questionnaire	Relevant Issues
Personal Data	Demographic groupings of ratings, pay grades, job types, equipments maintained, years in Navy and on job, etc., for all interviewees (– Names were left out intentionally)
"Description of Equipment" Information in Technical Manuals	Interviewees' opinions of: • Amount of descriptive information in manual • Suitability of technical level • Suitability of writing level • Treatment of visuals (figures and tables) • General comprehensibility and completeness • Choice of media for this information type • Frequency of use for this information type
"Theory" Information in Technical Manuals	Same as for "Description of Equipment" information, above
"Procedures" Information in Technical Manuals	Same as for "Description of Equipment" information, above plus: • Physical factors (size, storage space, usage space, problems such as foldout figures) • Tools/test equipment advice/instructions • Preferred content and formats for troubleshooting procedures • Need for explanatory text accompanying each step • Impact of spares factors on procedures use
General Questions	Interviewees' opinions of: • Most-used/least-used portions of manuals • Quantities and types of visuals preferred • Media preferences by type of information • Physical factors (size, plastic coatings, etc.) • Accessibility to manuals • Accuracy of manuals • Feedback for errors/inaccuracies • Use of manuals in training • Personal ownership of manuals • Implementing changes/updates in manuals • Implications of security classification levels • Training programs effect on maintenance and the job • Spare parts effect on maintenance and the job • Technical manuals effect on maintenance and the job • Tools/Test equipment effect on maintenance and the job

*In order of sequence addressed in questionnaire

2.3 SURVEY POPULATION AND SAMPLE

The Fleet Survey sample size of 427 was used to model the total population of Navy MOTD users. Stratification was given due consideration within the constraints of cost and schedule, and represented a sufficiently reasonable cross-section from which to draw significant conclusions.

Two pertinent factors exist in assessing the validity of the sample – sample size vs. the population size, and the stratification (i.e., the intentionally tailored diversity) of the sample vs. the heterogenous characteristics of the population. The sample size must take into account the error level deemed in advance to be tolerable, from which the confidence factor is derived, since this confidence factor has a pronounced effect on minimum sample size.

Population Characteristics – The population from which the survey was drawn is the collective set of Navy technicians who utilize technical manuals. This includes shipboard personnel employing MOTD for maintenance, operation and on-the-job/refresher training; shore-based maintenance personnel; and students and instructors in formal training situations. This array yields a great variety of Navy ships and installations, with a wide diversity of equipments, disciplines, and job tasks. Overall estimates of this total population exceed 150,000 individuals, based on a recent personnel study.[1] In the statistical sense, this population is said to be infinitely large, since its members far exceed the level at which further increases in population size impose any significant effects on requirements for minimum sample size.

Stratification and Skewing Factors – A reasonable cross-section of pertinent Navy ratings was achieved, within the constraints of cost, schedule, and availability of ships and interviewees. Table 2-3 indicates the breakdown of the 427 interviewees by ratings, with ratings grouped into three broad areas based upon the relative degree of abstractness or conceptualization associated with job tasks, in the judgment of NTIPP survey personnel. (Note that these three categories were derived empirically during the survey, based in exhibited characteristic and were not a result of any preconceived notions.) In addition, five questionnaires completed on a self interview basis (i.e., the questionnaires were left with the personnel for subsequent completion without an interviewer in attendance) did not list the appropriate rating requested; these are shown as "unclassified Navy Enlisted Men" in a separate category at the bottom of Table 2-3.

The top-level grouping was established by the NTIPP survey personnel as a means of subsequently analyzing responses, as the degree of conceptualization required in the conduct of job tasks was found to be responsible for significant differences in responses to several of the issues in the questionnaire.

To further enhance the stratification of the sample, responses were drawn from a variety of aircraft types (i.e. A-6, S-3, F-14, F-4, C-130) and ships ranging from submarines to tender/repair vessels to aircraft carriers. A full listing of the locations and activities visited is given in the next topic. Also, elements of the training community and key individuals in shore-based command and maintenance activities were included in the survey to enlarge the scope and

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[1] Powers, Thomas, Navy Enlisted Personnel Characteristics (Preliminary Analysis) ManTech Corporation of New Jersey, 30 June 1976. (Total derived from tabular listings of personnel strengths vs. ratings, pp IV-14 through IV-17.)

viewpoint of opinions involving MOTD to more than the immediate aircraft/shipboard maintenance environment. For reasons of survey cost and schedule, the subject survey was restricted to available elements of the Pacific Fleet and other military activities of proximity at the direction of the NTIPP Program Office, Code 186A, Bethesda, Maryland.

The choice of ratings involved in the interviews abroard the USS CONSTELLATION, CV-64, departed slightly from a purely statistical cross-section in that it included a deliberate emphasis on technical manuals associated with "mission-critical" systems. In the case of this aircraft carrier, such systems were taken from a list prepared by the PERA-CV activity at Puget Sound Shipyard at the request of Commander Robert Rein, COMNAVAIRPAC, Code 731.[2] For other duty stations, the widest available spectrum was requested based on ratings (i.e., mechanical, electro-mechanical, and electronics), and interviewees were obtained on that basis.

This departure from an ideal mathematical cross-section (which, for example, would give equal weighting to technical manuals for the main propulsion system and the food conveyor system) is viewed as in the Navy's best interest, since it biases the survey in favor of those equipments which are most important to performing the assigned missions of the respective ships.

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[2] Planning, Engineering, Repair, and Alteration for Aircraft Carriers (PERA-CV) CV), Puget Sound Naval Shipyard, Bremerton, Washington. List prepared by Mr. Glen Jurges of PERA-CV.

TABLE 2-3. OVERVIEW OF THE 427 INTERVIEWEES BY RATINGS

Rating Category	Ratings	Description	Number of Interviewees per Rating
Electronics (Highly Conceptualized) (Total of 177)	AE	Aviation Electrician's Mate	16
	AQ	Aviation Fire Control Technician	16
	AT, AV	Aviation Electronics Technician, Avionics Technician	46
	DS	Data Systems Technician	13
	ET	Electronic Technician	40
	EW	Electronic Warefare Technician	8
	FT	Fire Control Electrician	22
	RM	Radioman	3
	ST	Sonar Technician	12
	–	Shipboard Electronics Officer (LCDR)	1
Electro-mechanical and precision Mechanical (Total of 137)	AB	Aviation Boatswain's Mate (Launch and Recovery)	16
	AD, ADJ	Aviation Machinist's Mates	16
	AM	Aviation Structural Mechanic	13
	AO	Aviation Ordnanceman	13
	AS	Aviation Support Equipment Technician	3
	EM	Electrician's Mate	23
	GM	Gunner's Mate	15
	IC	Intercommunications Electrician	18
	IM, PI	Instrumentman, Precision Instrumentman	7
	MCLS	Senior Chief Molder	2
	MR	Machinery Repairman	3
	OM	Opticalman	6
	PH	Photographer's Mate	1
	PR	Aircrew Survival Equipmentman	1
Mechanical (Total of 108)	BR, BT	Boilermaker, Boiler Technician	24
	EN	Engineman	10
	FA, FN	Fireman's Apprentice, Fireman	3
	HT	Hull Technician	16
	MM	Machinist's Mate	49
	TM	Torpedoman's Mate	6
Unclassified Navy EM	–	–	5

2.4 CONDUCT OF THE SURVEY

This survey was conducted by the NTIPP Project Office to define MOTD problems in the Fleet and provide information needed by other areas of the present program. The survey was conducted during the months of November and December of 1976, and involved ships and activities of the Pacific Fleet.

The recently completed Fleet Survey of MOTD users by Hughes Aircraft Company was conducted by a task force of four to six men for four months. Early planning for the effort was begun in September 1976. The survey involved ten Navy Ships of various types, ranging in size from the aircraft carrier USS CONSTELLATION to repair ships and submarines. Nine shore-based installations involving aircraft and other maintenance and training activities were also visited as part of the survey, including COMNAVAIRPAC, from whom the survey team received welcomed advice, and to whom the NTIPP staff gave a results-to-date briefing on the survey effort. Personal interviews and replies to questionnaires passed out were obtained on 427 Navy personnel. These covered approximately 52 Navy ratings in the various occupation groups with a paygrade distribution from E2 to E9, the majority being in the E4 to E7 range.

The ships and shore-based installations visited by the NTIPP Fleet Survey Team are listed in Table 2-4, together with the date of visit, location and liaison/contacts for the visit. The activities visited were limited to those of the Pacific fleet for reasons of schedule and access. The widest array of ship and aircraft types were added to the survey team visits to incorporate the training and support activities responsible for various levels of Navy maintenance support.

The survey effort aboard the ships was conducted under difficult circumstances in many cases. Some ships were in for overhaul and alterations, resulting in chaotic situations. Many ship engineering areas were torn apart, and construction noises produced further distractions. Nevertheless, amidst this activity the ship's staff produced informative interview subjects.

In addition to the interview subjects, which encompassed a broad spectrum of ratings in the various occupation groups, some of the ship's officers gave the interview team many insights into other ship documentation areas where problems exist. Much of this documentation is classified under Ship Selected Records (SSR). These include Ship Information, General Information and Damage Control Books, Training Aid Booklets, etc.

During the survey, approximately 400 Navy personnel were subjects of direct, structured interview. Typically, a single interviewer handled about 4 or 5 interviewees per day. The survey team intentionally maintained a large degree of flexibility in placing emphasis where it was felt needed during the interviews, and constantly refined the accuracy of the direct structured interview techniques.

TABLE 2-4. SHIP AND SHORE INSTALLATIONS INVOLVED IN FLEET

Date of Survey (All 1976)	Ship or Shore Activity	Location	Survey Liaison Contacts
1-2 Nov	NAMTD-1001, VA-128 (A-6) Whidbey Island NAS	Oak Harbor, Wa	CDR R. Burke CDR J. Samar
3 Nov	PERA-CV, Puget Sount Naval Shipyard	Bremerton, Wa	Mr. Glen Jurges
4-5 Nov	NAMTD-1023 (F-4) and NAMTD-1078 (C-130) USMCAS	El Toro, Ca	LTCOL Simpson
8 Nov	63rd Military Airlift Wing (C-141)	Norton AFB, Ca	MSGT Butrus
9-12 Nov, 15-16 Nov, 22 Nov	USS CONSTELLATION Aircraft Carrier (CV-64)	Long Beach, Ca	CDR C. Wasson LT C. Wise
15-17 Nov	NAMTD-1008, AIMD and VF-211 (F-4/F-14)	Miramar NAS, Ca	CDR I. Hipper LT A. Halliday
17 Nov	COMNAVAIRPAC	San Diego, Ca	CDR R. Rein
18-19 Nov	USS TRIPOLI, Helicopter Carrier (LPH-10)	San Diego, Ca	CAPT L. E. Levensen LT B. Fraser
22-24 Nov	USS SPERRY, Submarine Tender (AS-12)	San Diego, Ca	M/Chief Andrews
23 Nov	USS AGERHOLM, Destroyer (DD-826)	San Diego, Ca	LT E.A. Bates
24 Nov	USS BRADLEY, Fast Frigate (FF-1041)	San Diego, Ca	LT Phelan
29-30 Nov	USS GRAY, Fast Frigate (FF-1054)	San Diego, Ca	CDR Nickerson LT Esterbrook LT Fauler
1-3 Dec	USS AJAX, Repair Ship (AR-6)	San Diego, Ca	M/Chief Kaiser
6-7 Dec	USS JOUETT, Missile Cruiser (CG-29)	San Diego, Ca	CDR Margoulis
8 Dec	DATC-FMAG	San Diego, Ca	Mr. R. Bohnfolk
8 Dec	COMNAVAIRPAC	San Diego, Ca	CDR Buchberger
9-10 Dec, 16-17 Dec	FLTRACEN	San Diego, Ca	LCDR R. Dickens
13-15 Dec	USS POLLACK, Submarine (SSN-603)	San Diego, Ca	LCDR W. L. Sellers
14-15 Dec	MOTU-5	San Diego, Ca	M/Chief Smith M/Chief Neuhauser
16 Dec	PEB-PACIFIC	San Diego, Ca	CDR Campbell CDR St. Laurent
17 Dec	SUPSHIPS	San Diego, Ca	Mr. B. Young
20-21 Dec	USS KINKAID, Destroyer (DD-965)	San Diego, Ca	CDR Chesborough

SECTION 3
SURVEY FINDINGS

3.1.1 PHYSICAL FACTORS VS. WORK SPACE ENVIRONMENT

Among the factors which impose limitations upon the practicality and effectiveness of MOTD use are the physical characteristics of the manuals and those of the work environment. More than one-third of the respondents indicated that their manuals are too big.

Tables 3-1 and 3-2 present the responses to the survey questions which are concerned with these human factors considerations. It should be noted here that the responses are organized in two ways. For those questions dealing with the work environment, responses are organized by "maintenance level" and presented in comparison with the "composite" responses which represent the entire survey sample. Organizational (O), Intermediate (I), and Depot (D) maintenance environments are generally quite distinct from one another. However, it was deemed advisable to include a fourth category of maintenance personnel, Organizational/Intermediate (O/I), since in certain operational settings it is common practice for a single individual to be designated to perform both categories of maintenance

For questions pertaining to the physical characteristics of the technical manuals, the organization of survey responses is based upon "type" of manual (i.e. used for certain types of jobs). To accomplish this comparison, the responses are organized into three groups of ratings: Those which are primarily electronic, those which are primarily electro-mechanical, and those which are essentially mechanical.

Work Environment – Overall, approximately one third of the sample indicated that they either had no place to put their manuals while working, or that the space available was inadequate. Although the problem is not quite so severe for the I-level personnel, as many as 44% - 45% of the O/I-level personnel felt that this was a problem.

Overall, small percentage of the individuals surveyed felt that there is insufficient lighting in their work environment to be able to read their tech manuals without any difficulty (approximately 15% overall). As might have been expected from the nature of their work areas, there was a higher than average concern expressed by the O-level personnel in this regard. Approximately 21% of these individuals felt that the lighting is a problem.

With regard to the accessibility of the manuals, the survey sample felt that the manuals are kept in their proper location for the most part, so that physical access to the data is not a significant problem. However, with regard to the ability of maintenance personnel to readily acquire needed technical manuals (i.e., from another source), approximately 25% of the survey sample expressed dissatisfaction, and this percent was found to be as high as 42% for the O/I-level personnel.

TABLE 3-1. RESPONSES INVOLVING PHYSICAL CHARACTERISTICS OF THE WORK SPACE ENVIRONMENT

Questions		% Organizational Maintenance	Organizational/ Intermediate Maintenance	% Intermediate Maintenance	% Depot Maintenance	% Composite
Do you have a place to put your manual while working?	Yes	62.6	53.3	77.7	50.0	59.9
	No	31.7	44.3	15.1	50.0	29.9
	No Response	5.5	2.2	7.0	0.0	10.0
Do you have enough space?	Yes	53.1	52.6	72.7	0.0	55.2
	No	36.5	45.1	20.2	50.0	33.2
	No Response	10.3	2.2	7.0	50.0	11.4
Is the light good enough where you work?	Yes	69.8	69.1	71.7	100.0	67.4
	No	21.4	16.5	14.1	0.0	15.6
	No Response	8.7	14.2	14.1	0.0	16.8
Can you get manuals easily when you need them?	Yes	69.8	54.8	72.7	50.0	63.4
	No	19.0	42.1	21.2	50.0	25.7
	No Response	11.1	3.0	6.0	0.0	10.7
Are they located where you need them?	Yes	76.9	82.7	84.8	100.0	78.2
	No	11.1	14.2	9.0	0.0	10.7
	No Response	11.9	3.0	6.0	0.0	11.0
Total Personnel Responding		126	133	99	2	427

NOTE: Percentages shown in this and all other tables may not total to 100% due to rounding errors incurred in expressing values to the nearest one-tenth of one percent.

3.1.1 PHYSICAL FACTORS VS. WORK SPACE ENVIRONMENT (Continued)

TM Physical Characteristics – As can be seen in Table 3-2, a great majority of those surveyed feel that the pages of technical manuals should be plastic-coated. This percentage runs as high as 86% among personnel comprising the "mechanical" ratings. The pattern of responses to this question was stated to be related with the work environment, indicating the tendency for pages to become soiled and thus decreasingly legible, and/or torn by use.

With regard to the size of the manuals, it was found that approximately one third of those surveyed felt that the tech manuals are "too big" and ought to be made a different size. Discussions with personnel confirmed that manuals should be smaller both in area and thickness. Further, this proportion is fairly evenly distributed over the different combinations of ratings.

One of the frequent complaints encountered by the survey team concerned the fact that, while in use, the manuals will not lie flat. As is indicated by the responses, nearly one half (approximately 48%) of those surveyed feel that this is a significant problem. This type of problem is related to the thickness of the manual, and is one which can significantly hamper the technician in the performance of maintenance tasks.

Another question addressed the manageability of the fold-out drawings contained in the vast majority of tech manuals. Once again, better than one third (35%) of those surveyed felt that the drawings were "too long" and, hence, unwieldly for use in the work environment. This problem is most acute for individuals comprising the mechanical ratings, where 39% noted their concern. Only slight concern was expressed by the "electronic" and "electro-mechanical" ratings over the size of the type used in printing. However, over 38% of the individuals in the "mechanical" ratings reported that the printing is not big enough to read easily. The significance of this finding is not clear at this time.

TABLE 3-2. RESPONSES INVOLVING PHYSICAL CHARACTERISTICS OF THE TECHNICAL MANUAL

Questions		% Electronic	% Electro-Mechanical	% Mechanical	% Composite
Should the pages of the manual be plastic coated?	Yes	67.0	73.1	86.9	73.7
	No	21.3	17.1	2.8	14.9
	No Response	11.5	9.7	10.2	11.2
Should some tech manuals be a different size?	Yes	30.0	32.0	25.2	29.0
	No	53.7	52.9	64.4	56.2
	No Response	16.1	14.9	10.2	14.7
Are the manuals too big?	Yes	38.7	35.8	32.7	35.8
	No	45.0	53.7	54.2	50.3
	No Response	16.1	10.4	13.0	13.8
Do you have trouble getting them to lie flat?	Yes	51.4	48.5	45.7	48.0
	No	34.1	38.8	40.1	37.4
	No Response	14.4	12.6	14.0	14.5
Are the drawings too long?	Yes	37.5	30.5	39.2	35.1
	No	45.6	47.7	42.0	45.6
	No Response	16.7	21.6	18.6	19.2
Is the printing big enough to read easily?	Yes	68.7	70.8	44.8	62.9
	No	10.4	17.1	38.3	19.4
	No Response	20.8	11.9	16.8	17.5
Total Personnel Responding		173	134	107	427

3.1.2 MEDIA: MICROFORM VS. PRINTED TMs

Although some 60% of all respondents reacted negatively to the use of microform as a singular MOTD medium, more than half were favorable to a mixture of microform and printed-TM media. However, many of the complaints involved microform reader/printer equipment, not the medium itself.

A strong negative reaction was voiced by MOTD users to the use of microform, except for parts listing, illustrated parts breakdowns, equipment specifications, and standards. As seen in Table 3-3, opposite, 60% of all respondents objected to the use of microform as a singular medium (i.e., placing MOTD *entirely on microform*). However, when offered the option of a mixture of microform and printed-TM media, over 50% reacted favorably.

Maintainer's Comments – The most prevalent complaints from the maintainer's view of microformed MOTD were:

(1) "It can't be used where it is needed (physically)."
(2) "I can't look at illustrations and text at the same time."
(3) "It's too hard to follow illustrations which are continued on following frames."
(4) "When the machine (microform reader/printer) breaks, we just have one more piece of equipment to fix."

Other compliants included the limited number and location of the microform readers and reader/printers, causing the technician to commute between his working location and his source of data. To lessen future commuting, he tends to "produce his own manual" by assembling pages of frequent need (cutting, splicing, etc.) for storage at his work location, much as he would a printed TM.

Training Comments – Training personnel interviewed at several Naval Air Maintenance and Training Detachments (NAMTRADETs) also expressed negative reactions to the microform medium. Instructors interviewed were nearly unanimous on the following points:

(1) Microform material is so poorly organized and broken between frames that instructors must generate supplementary handouts for classroom training to a much greater degree than for hard-copy manuals.
(2) Instructors prefer that their students have hard-copy manuals in front of them for annotation and reference.
(3) Most microform projectors have such poor resolution that they must be placed some forty feet from the screen to get a "decent" image.
(4) Since projectors typically have 10-foot control cords, the instructors must pace back and forth to change projections.
(5) The focus of the projected image of many microform projectors is not uniform over the entire frame; they tend to be clear in the center, with increasing fuzziness toward the outer perimeter.
(6) Multi-frame illustrations are not easily comprehended by students, and require too much backing up to get the entire picture.
(7) Too much trouble is experienced with frame search and retrieval; machines tend to overshoot or undershoot frame location.

Favorable Microform Comments – Respondents generally reacted positively when asked about the case of parts list, illustrated parts breakdowns, equipment specifications, standards, and similar data on microform. The reasons for this favorable reaction appears related to the differences in use when compared with other MOTD. First, the need for simultaneous access to more than one frame is dispensed with, and material is complete within a given frame. The technician's reference operation is one of straightforward part number lookup,

and the tabular listings appear quite amenable to the microform medium. Also, by the time a given part or kit number has been identified as needed, fault isolation has been completed; hence, the commuting problem does not apply.

TABLE 3-3. RESPONSES INVOLVING MOTD MEDIA FOR OVERALL USE

Question	Responses		Percentages	
Is Microform Better Than a Printed Book (for overall use)?	Yes	76	Yes	17.7
	No	256	No	59.9
	No response	95	No response	22.2
Should Technical Manuals Be a Mix of Microform and Printed Text?	Yes	228	Yes	53.3
	No	124	No	29.0
	No response	75	No response	17.5

3.1.3 MEDIA PREFERENCES WITH RESPECT TO SUBJECT

Survey responses indicate that the printed book is the most acceptable medium for presenting technical data to user. If maintenance performance is to be improved through use of another medium, the benefits and practicality of that medium must first be demonstrated to the user before it is likely to be accepted in the maintenance environment.

Figure 3-1 depicts media preferences by TM information categories, arranged in declining percentages of preference for printed TMs. The overwhelming preference for the printed TM over alternative media is apparent. These results are consistent with cross-check inquiries which indicated that 60% of the respondents preferred the printed TM for overall use, compared with 18% who preferred microform on an overall basis. In the preferences per information category shown in the figure, microform placed a distant second, or in some cases (e.g. troubleshooting procedures and theory of operation) ranked third. The slightly declining percentages of preference for the printed TM in the last two information categories correlate well with other responses indicating that the theory and equipment description sections were less-used than were the procedures.

Preferences for other presentation media were weaker than microfilm in all subjects except for troubleshooting procedures and theory of operation. The audio-visual medium was preferred over microfilm for theory of operation, and a CRT/keyboard medium was preferred over microfilm for troubleshooting. This was not surprising, since most maintenance personnel interviewed were unfamiliar with (or had no prior association with) these media except in classroom situations.

Preference for the printed book in the classroom and learning situation* corresponds with the media-by-subject preferences. Equipment descriptions and theory of operation are preferred in printed form over the film medium by 38% to 15% and 52% to 23%, respectively, by the same respondents. A combination of the film and printed media was favored by 30% of the respondents in learning descriptive material. Preference for learning descriptive material and theory of operation by the audio medium was only 2%.

Many of the 427 respondents showed a reluctance to consider how their maintenance performance might be enhanced by new presentation media, and expressed their animosities toward microfilm. Many felt there was a place for both the printed book and microfilm in their work environments, with microfilm assuming the role of listings, tabular data, and even theory. For other information categories, the predominant attitude is best expressed as, "Give me my schematics and diagrams in one piece, so I can see all of them at the same time." This last item was expressed by an electronics maintainer; hence, the reference to schematics and diagrams. However, respondents in all rates expressed the same basic sentiment; thus the comment is typical.

Parenthetically, the men in the fleet often said the CRT (keyboard and such) would be nice but would cost too much. The consciousnous of costs recurred frequently, reflecting a true cost-consciousnous on the part of these maintainers.

*This data is tabulated in Table 3-16 (Topic 3.4). Further details are provided in that portion of the report.

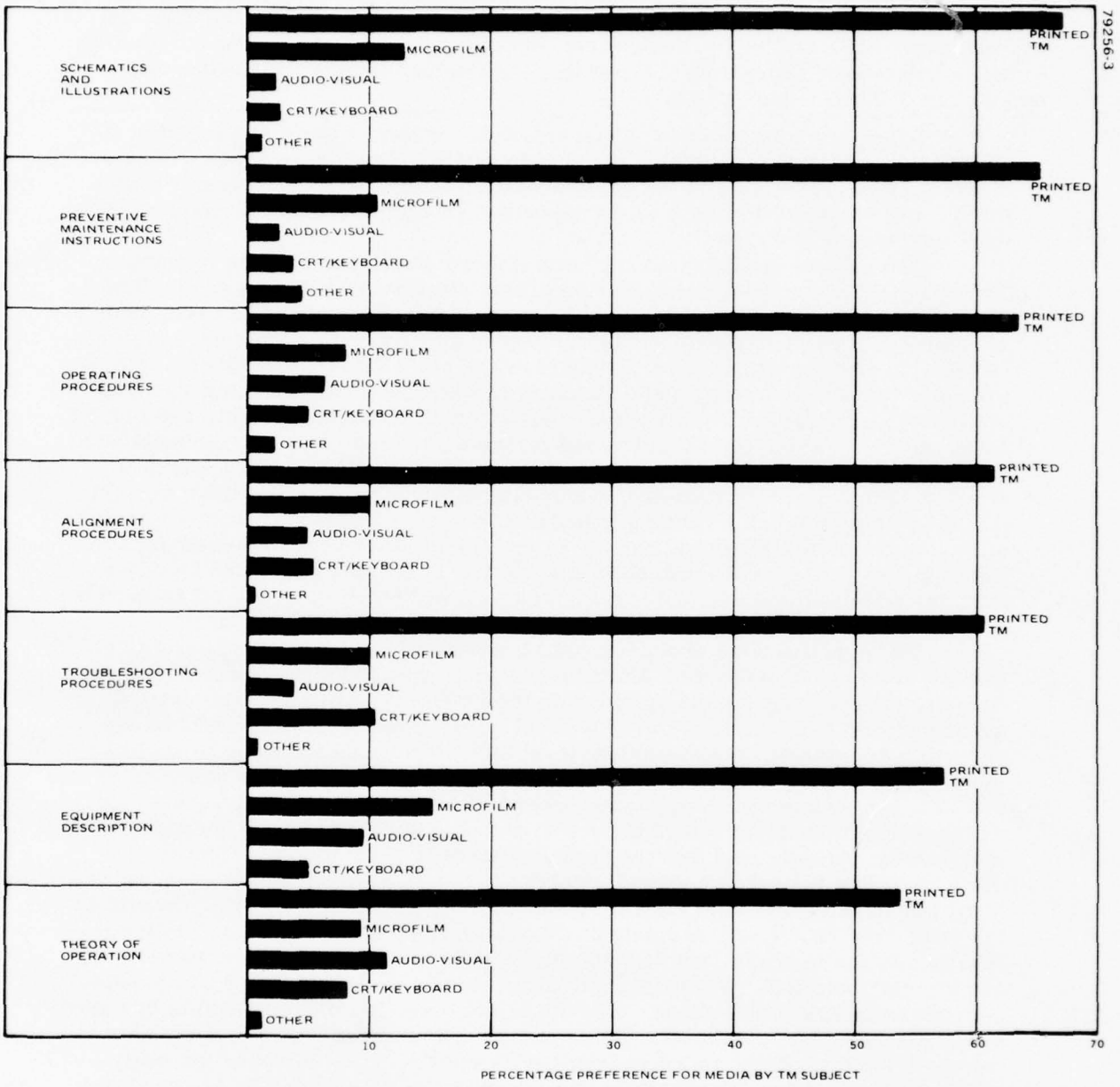

Figure 3-1. Media Preferences versus Type of Data Being Presented. The user shows a distinct preference for the familiar printed TM.

3.2.1 DESCRIPTION AND THEORY

A majority of respondents offered no major complaint concerning the technical level, writing level, and handling of illustrations and tables in the Description and Theory sections. However, more than half felt that insufficient amounts of theory were included in their technical manuals.

Descriptive Material in MOTD – A wide variety of types and formats of descriptive material is found in technical manuals. The "Description of Equipment" section referred to in the questionnaire was defined as the information in the front of technical manuals which describes an equipment's basic physical and functional characteristics.

The subject of "front matter" was also raised in some of the interviews. This was treated as a logical extension of this section and noted as such. The "front matter" is defined as title pages, change/corrections record page, table of contents, lists of illustrations/tables, index and glossary. This group of data is used, in varying degrees, by all users. The main thrust of comments in this area was that good indexing and a glossary are both needed. Indexing was often criticized as appearing to be a cursory effort, with little forethought, and thus of little value. Indexes were found to use nomenclature that does not communicate well. The glossary is the element most often left out. This may be due to it being an optional or "as required" component cited by the specification; as such, it invites being left out. These particular portions of technical manuals were most criticized by CPOs, and notably in the Mobile Technical Unit organization. This implies that given enough Navy experience, such men have seen technical manuals with good indexes and glossaries. A few interviewees had never used a technical manual containing a glossary.

The questionnaire also addressed the general-information-description section of technical manuals. Maintenance personnel and other users of technical data were surveyed for their opinions on the technical level, writing, clarity, accuracy, and completeness of the general information. The focus was on the descriptive material. The technical level was "about right" for the needs of a majority (68%) of those surveyed. It was too simple for 8%, too hard for 12%, and 12% had no opinion. Many interviewees feel that it is too hard because the writiers do not consider the readers who have to use this data. Some personnel (mechanical ratings) said that the technical level in description of Control Systems was often too hard because it contained complicated formulas. The writing level was considered about right by most (60.6%), too hard to 13.3%, too simple for 5.3%, and 20.6% had no opinion. The interviewees state that the writing level varies with the manuals, and that the writers do not appear to write with the reader/user in mind. While 19.6% find the writing confusing, 70.9% of those surveyed expressed no opinion. The description section was believed to be clear and logical by 68.3%, with 16.3% dissenting. Some of the negative comments were: "The description is too generalized because it tries to cover too many ships' systems," and "Description text for complicated systems does not always agree with the illustrations." Most of the interviewees (56.4%) believe description data is complete but only 24.3% think it is accurate. Approximately 71% of the maintenance personnel find the descriptive data useful.

Maintenance personnel generally indicate that descriptive material is of minimal value for maintenance, however it is useful in familiarization and training applications. The utilization of this data varies among the ratings and pay grades. Representative samples of the survey data showing use of descriptive

material by pay grade and rating are shown in Tables 3-4 and 3-5. It was noted that the frequency of use increases from "rarely used" by the E5 to primary use by the E5, but the E6 uses it for both maintenance and training. The E7, E8 and E9 grades usually use the descriptive material for training.

About 40% of personnel surveyed preferred the printed-TM medium for this information category. A significant group (30%) would like an audio/visual method of learning and using this data. This was a strong indication by engineering and hull ratings. Machinist ratings would like an audio/visual method for description and printed-book Illustrated Parts Breakdowns (IPB) of equipments.

Theory section in MOTD – The principal uses of the theory section are training and maintenance. Some maintenance personnel (primarily electronics maintainers) use it to support the troubleshooting procedures. During the interviews, users explained why the theory section was not used, or not used more. Most indicated that the theory section did not meet the users' needs. There is a variation in this need. It is useful to the lesser-trained and experienced man (E4, E5), but is needed less by the more expert (E6 and above). Many of the highly trained Senior Petty Officers have the expertise to perform troubleshooting using other data (schematics, logic diagrams, etc.), and rarely use the

TABLE 3-4. USE OF GENERAL DESCRIPTION INFORMATION BY TYPICAL RATINGS

Rating	Rarely Use	Sometimes Use	Often Use	Usual Purpose of Use
AT	30%	55%	15%	Familiarization and Training
BT	25%	70%	5%	Maintenance
HT	20%	65%	15%	Maintenance
FT	10%	75%	15%	Maintenance

TABLE 3-5. USE OF GENERAL DESCRIPTION INFORMATION BY PAY GRADES

Pay Grade	Relative Frequency of Use	Usual Purpose of Use
E7, E8, and E9	Use most of the time	Training
E6	Sometimes Use	Training and Maintenance
E5 and Lower	Rarely Use	Maintenance

3.2.1 DESCRIPTION AND THEORY (Continued)

theory section. However, they use it for very difficult or unusual troubleshooting problems.

In the survey, users were asked for their opinions about the technical level, clarity, writing level, accuracy and completeness of text and diagrams in the theory section. This opinion profile is shown in Table 3-6. Most maintainers would like more theory. This is based upon the fact that only 46.4% think there is enough theory. It was further supported by statements made during face-to-face interviews. More than half of those surveyed think that the technical level, writing level, clarity, logical content, and accuracy and completeness of diagrams is about right. This raises the question of why theory is not used more frequently. As stated by a senior maintenance man, "there is not enough detailed information for the maintenance man."

The use of the theory section varies among rating types, e.g., mechanical vs. electronic. The engineering ratings (mechanical) use it frequently in normal training applications. But, they state, it is rarely used in shipboard maintenance actions. Senior Chief Petty Officers, assigned as instructors for the Engineering Watch Officers School, state that it is used most of the time. Senior Chief Petty Officers, in electronic ratings, indicate that theory is used for formal training, on-the-job-training, and when re-familiarizing a maintainer for an equipment. It is also used in conjunction with the troubleshooting procedures during maintenance actions.

TABLE 3-6. OPINION PROFILE FOR FEATURES OF THEORY SECTION

Inquiry Features	Yes	No or No Opinion
Enough Theory?	46.4%	53.6%
Technical Level About Right?	62.3%	35.7%
Material Clear and Logical?	60.7%	39.3%
Writing Level About Right?	67.7%	32.3%
Diagrams Good?	58.7%	41.3%
Theory Section Used Frequently?	42.9%	57.1%

3.2.2 OPERATING PROCEDURES

A majority of all respondents indicate that operating procedures coverage is adequate and that the printed book medium is preferred for this type of information.

Operating Procedures is a very general term which conveys a different meaning to operators than to maintenance personnel. An Operations Instructions Manual is a manual containing instructions required to operate specific equipment (s), and is the type of operating procedures familiar to maintenance-oriented personnel. However, to the operationally oriented personnel (e.g., Operations Specialists, etc.), "operating procedures" means tactical operation of the equipment to satisfy the Required Operational Capabilities (ROC) which must be performed by the ship or aircraft. In the survey, the principal objective was to cover operating procedures related to the maintenance personnel, and specifically the operating procedures section of technical manuals. However, information was obtained to determine the impact of operating procedures on all personnel who may be users of this data.

Three categories of personnel can be considered as users, to some extent, of this data: maintainers, maintainers/operators, and operators. Maintainers are defined as those whose primary duties are to perform maintenance. Maintainers/operators perform maintenance, and are also required to operate the equipment. Operators are primarily responsible for operating the equipment. Secondary responsibilities include operator's preventive maintenance as directed by the PMS subsystem of the Maintenance, Material, and Management (3M) System. Similarities exist in the man-data interfaces which cut across the three categories.

In general, the operating procedures are used by maintenance personnel to operate the equipment/system as needed for performance of maintenance. The operators use the procedures to start, adjust, align, control and stop the equipment as necessary to efficiently fulfill tactical operational requirements. Therefore, both need to know the procedures, but for different purposes. There is a man-to-man data interface between operators and maintainers. The operator's observations of the malfunction, his evaluation, and subsequent description of equipment(s) symptoms represent important information for the maintainer. In many instances, this is a contributory factor in reducing the Mean-Time-To-Repair (MTTR). Periodically, the operators use the operating procedures for the same purpose as the maintainers - performance of maintenance actions which have been assigned to operators.

Operating procedures have been developed in numerous formats. During the survey, the maintainers in mechanical ratings referred the interviewers to operating procedures manuals which were considered very good for their user-data needs. These are the Engineering Operational Sequencing System (EOSS) manuals, described further in Topic 3.2.7. One manual, (Engineering Operations Procedures (EOP), is used for normal light-off and operation of the steam propulsion plant. Another manual, Engineering Operational Casualty Control (EOCC), provides the operator(s) data needed to control casualties to the steam propulsion plant. These manuals were developed as the solution for the lack of adequate, standardized operating procedures. Direction, advice, and assistance was provided by the Propulsion Examining Board (PEB) and others to ensure that the procedures addressed the operators' needs. Upon installation in the ship the basic, detailed procedures are modified and validated for the particular propulsion system on baord. Ships of the same class typically have some minor

variations in their equipments and type of installation. The users of these manuals indicated that significant improvements have been noted in equipment/system reliability, maintainability, operability and operational readiness. Another improvement noted was that operators like the EOSS manuals for self-training applications.

The MOTD operating procedures provided for maintenance personnel are used for another purpose – to develop Standard Operating Procedures (SOPs) for operator use. The SOPs are written by fleet personnel on the ship, type command, etc., who use the operating procedures in the MOTD as reference material. This presents a strong ripple effect through data which is not subject to maintenance by the normal update process. It is entirely conceivable that any incorrect procedural data resulting from a poorly controlled and managed validation/verification effort could be magnified by the ripple effect, in its impact on the producers of the SOPs. The magnification effect is caused by using a single (e.g., bad, in this hypothetical instance) procedure in a number of SOPs and at more than one operator station such as found in CICs. A further magnification occurs in that the procedure will be used to produce SOPs on all ships having the same equipment. This is not to imply that the Navy operator will continue to operate using a bad procedure. It was noted in many cases that the Navy man (whether an operator, maintainer or instructor) will find ways to work around poor or missing MOTD. The result of this tendency, when put into the context of producing SOPs, is that the different ship's forces will find different solutions to the same problem and all the problems resulting from a lack of standardization will ensue.

The specific survey questions which measured opinions of the maintenance personnel about the operating procedures are shown in Tables 3-7 and 3-8 on the following pages. Opinions for each of three occupational categorization groups are shown, as well as the total survey as a group. Some of those interviewed had no opinion primarily because they did not use or need those procedures for their work. It is significant that 63.2% of the survey think the procedures are about right. The electronic group has 16.1% who think the procedures are too long as compared with 11.5% who think it is too short. Therefore, it would be reasonable to assume that more detail in operating procedures is not needed. In fact, the same opinion trend is noted for all the groups. The mechanical group has the least percentage (9.7%) of personnel who think the procedures are too short, but that group is second highest (64.6%) is assessing the procedures as about right.

The survey also elicited opinions on the media in which respondents would like to have the operating procedures presented. The order of preference is printed book, microform, audio/visual, CRT with keyboard, and other. A no-opinion group was used for those who did not express a preference. It is significant that 64.1% of those surveyed prefer to retain the printed book. Another opinion worthy of more attention is the 10.6% of the mechanical rating group who like the audio/visual presentation method. (It had been expected that the electronic group was more likely to accept innovative uses of audio/visual presentations of technical data.)

It appears that the printed book for MOTD is the first choice of maintenance personnel. After the no-opinion responses are removed, the microform method is next with only 8.1%. It is followed closely by the audio/visual methods which had 7.0%.

3.2.2 OPERATING PROCEDURES (Continued)

Spontaneous complimentary statements about the procedures were rare. One such statement made by a Senior Chief Petty Officer was that the operating (and all) procedures in the Warren Fire Pump (500GPM) manual were very good. Another Chief Petty Officer said that the operating procedures for his spot-welder technical manual were written in the modes of operation format which he found useful and thought it to be a good feature. The operating procedures format was mentioned again when a Senior Chief Petty Officer of a different rating described the problem in his manuals. He felt the various operating modes for an equipment should not be combined as one procedure, but should be recognized as different operating modes. This comment was received numerous times.

The majority of the unfavorable comments were: too many inaccuracies, too many abbreviations and acronyms, too confusing, ambiguous, does not include minor precautions required, covers too many modes or configurations in one procedure, and does not conform with equipment that has been modified. The users are essentially saying that this class of technical manual information does not meet the user-data match they require.

TABLE 3-7. DEGREE OF COVERAGE FOR MOTD OPERATING PROCEDURES

Operating Procedures Are:	Electronic Group	Electrol Mechanical Group	Mechanical Group	Total Survey Group
Too Long	16.1%	14.1%	11.5%	13.5%
About Right	61.2%	64.9%	64.6%	63.2%
Too Short	11.5%	10.4%	9.7%	10.5%
No Opinion	10.9%	10.4%	14.1%	12.6%

TABLE 3-8. MEDIA PREFERENCES FOR MOTD OPERATING PROCEDURES

Presentation Media	Electronic Group	Electro Mechanical Group	Mechanical Group	Total Survey Group
Printed Book	59.9%	71.6%	64.6%	64.1%
Microform	10.4%	5.9%	7.0%	8.1%
Audio/Visual	5.7%	8.2%	10.6%	7.0%
CRT W/Keyboard	6.9%	5.2%	1.7%	5.1%
Some Other Way	1.7%	0.0%	4.4%	1.4%
No Opinion	15.6%	8.9%	11.5%	14.0%

3.2.3 TOOLS AND TEST EQUIPMENT

Identification and application information concerning tools and test equipment needed for maintenance is not sufficiently or properly addressed in MOTD. Although more than half (55%) of maintenance personnel surveyed believe that common tools and test equipment are adequately described, this response changes markedly when "special" tools and test equipments are discussed.

Maintenance personnel have long been aware of the importance of tool and test equipment information in MOTD for maintenance use. This information assists maintenance planning and saves man-hours and maintenance efforts. Jobs that would be delayed by the lack of proper tools/test equipments are not started. The maintainers say, "I need to know what tools and test equipment are needed before I begin the job."

In the survey, detailed opinions were sought concerning the listing in MOTD of tools and test equipment needed for maintenance. More than half (55%) of those surveyed feel that the MOTD adequately lists tools and test equipment needed for the job (re. Table 3-9), but they recognize that this is a listing on only the common tools and test equipments. The mechanical rating group has the largest percentage (45%) that find these listing in MOTD inadequate for the job. The electronic rating group has the highest percentage (64.7%) believing the tools and test equipments lists are adequate, But, the 25.4% who believe the contrary is true is a significant percentage. During the interviews, unsolicited opinions from the majority indicate that the MRC cards used in PMS do adequately list the tools, test equipments, and materials needed for the job.

Significant numbers of maintenance personnel believe that more tool and test equipment information should be in MOTD. Aviation electronic ratings would like MOTD to contain the part or reference number for each item. (This would make it easier to obtain the item from the tool locker when needed.) Some maintainers want the tools and test equipments listed with the procedural step in which that item is used. Numerous Petty Officers and Chief Petty Officers want an equivalent, alternate, or substitute list of tools and test equipments in MOTD. One Chief Petty Officer states that the SIMM manual has a good method of listing the tools and test equipments with the alternate which can be used for the job.

Application of the tools and test equipment in maintenance is another problem. In general, maintainers would like more information about use of complex test equipments, especially for difficult and/or tedious jobs. Survey opinions were obtained for this question: "Should the procedures tell you how to use tools and test equipment in great detail, in a general way, or not at all?" The data obtained from the question is shown in Table 3-9. Of those interviewed, 83.5% would like some detail of information in MOTD about the use of tools and test equipment. This percentage is almost equally divided between those who want great detail and those wanting general detail. Only 36.4% of the electronic ratings maintainers want great detail information. This is the lowest of the three groups. Most of those interviewed want great detail in information for specialized tools or test equipments. "Especially for the lesser skilled or trained maintainers" was the unsolicited response most often given. Those who work in precision instrument calibration are governed by calibration standards and want test equipment information in great detail. Electronic technicians want more test equipment set-up information in MOTD.

"MOTD information about tools and test equipments should provide sufficient detail for the maintainer to do his job." This statement by a Senior Petty Officer best summarizes the need. Tool and test equipment information has to be user/job-related.

TABLE 3-9. TOOLS AND TEST EQUIPMENT RESPONSES

MOTD Should Explain the Use of Tools and Test Equipment in:

	Electronic Group (%)	Electro-Mech Group (%)	Mechanical Group (%)	Total Survey Group (%)
Great Detail	36.4	46.2	43.9	41.6
General Detail	48.5	35.0	41.1	41.9
No Detail	4.6	6.7	6.5	5.8
No Opinion	10.4	11.9	8.4	10.5
Does MOTD List All Tools and Test Equipment Needed for Job?				
Yes	64.7	56.7	44.2	55.5
No	25.4	34.3	45.1	34.1
No Opinion	9.9	9.0	10.7	10.4

3.2.4 TROUBLESHOOTING PROCEDURES

Many interviewees stated that MOTD coverage of troubleshooting procedures is inadequate and need improvement.

Maintainers consider troubleshooting to be the critical element in corrective maintenance. Malfunctions in equipment/systems which are critical to mission performance require rapid isolation and correction. The isolation and repair must be performed within the minimum time possible, which places a sizeable burden on troubleshooting procedures to help maintainers perform the task easily and efficiently.

The most common response, and often stated most emphatically, was that the troubleshooting procedures do not work. Probing brought out the fact that the difficulties encountered were in isolating the fault, and in taking too long or circuitous paths of fault isolation, which require time the maintainer simply does not have. Many of the maintainers do not use the troubleshooting procedures at all. Those in electronic ratings with sufficient training and experience use schematics, diagrams and their own expertise to locate the fault. Most electronic equipments and systems will exhibit tendencies towards certain failures which become detectable through a pattern recognition after a period of time in service. The highly motivated maintainer will troubleshoot faster, using logical deduction and empirically derived data, (which may take the form of notes or thoughts), than using MOTD procedures. The reliance on logic and empirical data becomes much greater when the MOTD procedures do not isolate faults or use unwieldly procedures to get to the fault.

The criticism of not finding the fault occurred often when questioning in the troubleshooting area. The complaint was that the list of malfunctions and symptoms provided by the manufacturer were rarely the ones which occurred in the operating environment. The respondents want "real-world faults" in the troubleshooting section. The maintainers routinely correct these "real-world faults," but do not report by use of the feedback system due to problems exhibited in that area. (See Topics 3.5.2 and 4.5 for further information on feedback.)

Fault Isolation Technique, One – The troubleshooting procedures often use poor fault isolation techniques. Three basic techniques are used in most cases, with various combinations being used in others. The first is step-by-step procedures, which were the most favored technique. In the composite group shown in Table 3-10, 45.6% preferred this technique with the electro-mechanical and mechanical ratings being highest at 52.9% and 56.0% respectively.

Fault Isolation Technique, Two – The second technique considered is the tables-and-pictures method which was intended to mean a symptom-table that is well illustrated. This question did not communicate this intent as well as was hoped; therefore, the preference profile may be a little low, especially for the electro-mechanical and mechanical ratings. (This supposition is at least partially supported for the mechanical rating in that significant numbers of these respondents stated a preference for the Chilton Auto Repair/Motor Manual type of MOTD, and these use the symptom table approach.) The composite here was 13.8%, with the electronics ratings reporting 12.1%, the electro-mechanical ratings reporting 11.1%, and the mechanical ratings reporting 19.6% preference. Some respondents did make a second choice on this question, and for those who did (approximately 25% of the total) 56.6% preferred this as the second choice.

Fault Isolation Technique, Three – The third consideration was flow charts. Some of the troubleshooting procedures mentioned were in flow chart

format, and were very well received. The respondents who had these good experiences were usually E3s and E4s in electronic ratings. Some strong adverse reactions to flow charts were also expressed. These were usually E7s and up, in electronic ratings who had more experience and had been exposed to older, less modularized equipments, and often reported being exposed to flow charts which were poorly executed. If given the qualification of "flow charts that are done right," it was found that the technique was quite acceptable. The electronic ratings showed the highest preference at 36.9%, with the electro-mechanical ratings at 24.6% and the mechanical ratings at only 10.2%. This has a direct correlation to equipment in that electronic equipment lends itself more to flow chart analysis, accounting for the electronics and some of the electro-mechanical ratings responses. Mechanical equipment is more readily fault-isolated by physical inspection (i.e., observation of visible, audible, olfactory, or tactile factors) and is not readily presented in flow chart form.

In the overall response to troubleshooting procedures, only 35.3% felt the procedures were about right (re. Table 3-10). The significant number is the 44.2% who felt they were too short. The mechanical ratings reported 53.9% in this area, which can be attributed at least partially to a number of problems in this general area.

The subject of improvement of the troubleshooting procedures was more extensive than was anticipated when the questionnaire was developed. The question addressing this subject was "How would you improve this section? With more pictures, diagrams, and schematics maybe?" As the interviews progressed, the survey team noted that this question developed frustrations in interviewees and resulted in indirect answers. The general trend of the answers was: "We need more good fault isolation." "Give me procedures for the stuff that breaks." Pursuance of these complaints caused a slight change in the answers used. The "Other" category was used to accumulate these complaints. The overall result was 44% answered in this manner indicating that something needed improvement beyond just pictures and diagrams. The answer by job category shows a trend from electronics ratings at 50.2%, electro-mechanical ratings at 42.5% through to the mechanicals ratings at 37.3% which would indicate that the more complex and conceptualized an equipment/ system is, the more the need for improvement is felt.

One item which was given by the interviewees in pursuing this general area of interest was in the Maintenance Dependency Charts (MDCs) used in SIMMs and FOMMs formatted MOTD. A majority of the users interviewed do not like these charts, and do not use them. The few who did like and use them were the ones who understood them. One respondent said: "I figured these things out (the MDCs) and they work pretty good. But if you are going to give this kind of stuff to the sailors, you had better give them some training." This man was an E6, and had had much difficulty with the younger maintainers not using MDCs. The whole point, as agreed to by various respondents queried, is that if new techniques are going to be used, some "real-world" evaluations are going to have to be made – items such as: Are they useful at the work station? Do they require selling to the user? Should this be introduced by a training program of some type?

TABLE 3-10. RESPONSES INVOLVING TROUBLESHOOTING

Question	Response	Electronic Group	Electro-Mechanical Group	Mechanical Group	All Respondents
Troubleshooting Procedures in the MOTD are:	Too long	11.1%	6.0%	4.5%	7.8%
	About Right	34.1%	41.0%	33.6%	35.3%
	Too Short	40.4%	42.5%	53.9%	44.2%
	No opinion	14.5%	10.5%	8.0%	12.7%
This section could be improved by:	More pictures	12.7%	17.9%	24.2%	17.7%
	More diagrams	13.8%	20.1%	20.5%	17.0%
	More schematics	4.0%	6.7%	3.7%	4.9%
	Other	50.2%	42.5%	37.3%	44.0%
	No opinion	19.0%	12.6%	14.0%	16.1%
Troubleshooting Procedures Should:	Be step-by-step	33.5%	52.9%	56.0%	45.6%
	Contain Tables and Pictures	12.1%	11.1%	19.6%	13.8%
	Contain Other Things	1.1%	0.7%	0.0%	0.7%
	No opinion	16.1%	10.4%	14.0%	14.0%

3.2.5 LIMITING THE LEVEL OF COVERAGE TO THE SPARED REPLACEABLE ITEM

Maintainers responsible for the readiness of complex electronic shipboard equipments/systems indicate a need for MOTD beyond the level indicated by the "maintenance philosophy" of that equipment/system, so as to effect repairs when spare items are not available. This repair level is critical when encountered under "emergency-at-sea" conditions for mission-critical equipment/systems.

The level of detail provided in current MOTD was severely criticized by senior maintenance interviewees responsible for complex electronic systems. In most examples cited, the "maintenance philosophy" employed by the SHAPM was to provide MOTD down to the level of the spared replaceable item. The scenario cited by the E-6 through E-9 level personnel responsible for maintenance of NAVSEA and NAVELEX equipments/systems centered upon the condition wherein a fault had been isolated to a specific spared replaceable item, but a spare was not on board, either due to increased usage or resupply difficulties. Since a high percentage of these complex electronics systems are often mission-critical, the maintainers come under extreme pressure to effect a repair on the faulty item. The dilemma faced by this maintainer is to determine how to proceed with the repair when no MOTD is available for the item.

This is a situation which does not exist in the support of NAVAIR equipment/systems. The fundamental "black-box replacement" concept utilized by NAVAIR on the weapons system (i.e., the aircraft) results in a larger quantity of available spare replaceable items, greater MOTD depth as a result of the AIMD organization, and the reflection of a smaller impact on Full Systems Capability since only one aircraft is taken out of service.

The importance of this MOTD void is that maintenance personnel responsible for NAVSEA and NAVELEX equipment/systems are requesting that MOTD be provided to a level of detail below the spared replaceable item level (e.g., MOTD level as given to AIMD maintainers) to enable them to effect repairs under "emergency-at-sea" conditions. Further, this MOTD need not be provided to the limited experience level of the E-4 sailor/technicians, but to the E7 – E9 level, since normally the senior people accomplish this type of repair.

An additional comment on the NAVAIR equipment is in order. It is suspected that the automatic test equipment (ATE) on board the carrier, and other NAVAIR equipment/system (CV-TSC as an example) which remain on board, may be in a similar state of difficulty. A highly experienced instructor indicated an extreme problem in this area. He stated that it took too much talent to fix this equipment with the MOTD furnished. Pursuing this revealed the problem is complex equipment, a spares problem and MOTD that is confusing without being detailed enough.

3.2.6 IMPACT OF VOIDS IN SHIPS SELECTED RECORDS

The MOTD which NTIPP is studying is a part of Ships Selected Records (SSRs), thus when user problems were identified as being in the SSR realm, the subject was investigated within the context of the Fleet Survey. The value of SSRs as a primary data source for the fleet user is seriously degraded by their lack of currency.

It is recognized that the focus of NTIPP is on that class of MOTD commonly identified as "technical manuals;" however, the necessity to provide a comprehensive design requires that the contractor be aware of other forms of MOTD in fleet use. If this is not tracked, the risk lies in identifying an MOTD void from a "technical manual" viewpoint only to find that some other portion of the Ships Selected Records fulfills the requirement and bridges that "MOTD void." For this reason this Fleet Survey was not restricted to "technical manuals" only, but sought to place the "technical manuals" subset within the proper context of the Ships Selected Records as the MOTD set.

Ships Selected Records (SSRs) are defined by the "General Specification for Ships of the United States Navy," NAVSHIPS 0902-001-5000 (apparently this specification is a "technical manual"). The SSR data is declared as being "... of significant value to ships operation, maintenance and logistics requirements," and are divided into four subsets: 1) Selected Record Drawings, 2) Selected Record Data, 3) Allowance List (ALs and COSALs) and Ships Manning Documents. The Selected Record Data subset is further segmented and includes Ships Information Books (SIBs), General Information Books (GIBs), technical manuals (TMs), Damage Control Books, Training Aid Books (submarines only), Propulsion Operating Guides (POGs), Ships Drawing Indexes, and an Index of Technical Manuals in addition to other documents for certain types (and classes) of ships.

The currency of SSRs is the responsibility of the Planning Yard for the specific ship or ship class. The SSRs are to be updated and maintained during periods of Restricted Availability, Overhaul, and the like. Ostensibly, the Planning Yard is to update, correct, and add information to the extent necessary to give the ship a current set of Ships Selected Records. Interview sources stated that the required updates of SSRs by the Planning Yard were rarely accomplished, and when addressed by the Planning Yard the effort was largely prefunctory. This results in a chaotic state of relevance of the SSRs – the older the ship, the worse the state of currency of the SSRs as a data base. The consequent action is that the technicians simply do not utilize or even access many of the data sources in the SSRs since these sources are often not reliable.

The NTIPP Fleet Survey was not intended to provide an exhaustive study of the Ships Selected Records. However, it would be unwise to ignore some of the survey findings, merely because they relate to the Ship Selected Records. Since these findings are not fully comprehensive, they are best viewed as examples which should be considered as symptoms which may or may not indicate that a more detailed examination of SSRs be undertaken. (See Figure 3-2.)

Example 1: During the conduct of a ship check conducted by SUPSHIPS, San Diego aboard the USS FOSTER (DD 964), a reasonably new ship, it was found that approximately 3000 labeling-to-drawing discrepancies existed in the damage control area. These errors will only get worse as shipalts and field changes are installed, unless a correct record is accomplished. A further source of trouble is that Compartment Checkoff Lists are posted in each respective compartment for use in critical circumstances. These lists were made up to the same baseline data, consequently reflect many of the same 3000 errors, and have no provision for update.

Example 2: In an interview with a Master Chief Hull Technician and a Chief Aviation Boatswain Mate Fuel Handling Specialist, it was found that each had experienced past difficulties with ships drawings and SIBs to the point where neither man trusted them. The HTCM was aboard a new ship which was experiencing difficulty in firing the main boiler. It was found, by talking to a shipyard worker, that the fuel supply system was installed in a closed-loop which did not include the boiler. It was further noted that the installation did not match the drawings (which were for a class of ship) and that the Selected Record Data was also wrong. The ABFC had found by experience that the Ships Selected Record data was not to be trusted. He stated that whenever he went aboard a new ship, he did a personal check of the fuel handling equipment and made his own notebook. This provides a "transfer of knowledge" problem when he transfers, and does not update the poor Selected Record Data.

Example 3: Aboard the USS CONSTELLATION (CV 64) a pair of manuals were shown to the survey team by a Boiler Technician 1st Class: these provided coverage of all the controls and indicators in the engine rooms in one book, and all the engine room valves in the other. These books have no publications number, no publications date, and by inference are uncontrolled. The books were produced by Art Anderson and Associates, Inc., of Bremerton, Washington, and were obtained through the auspices of PERA-CV. They are the primary reference document for this equipment on this ship.

It should be noted that one of the provisions for obtaining SSR update comments is through the ship commander when the ship is scheduled for any yard activity. This provides the opportunity for the ship's force to input the correct data, but it is rarely used. The reasons for this could only be conjectured at this point.

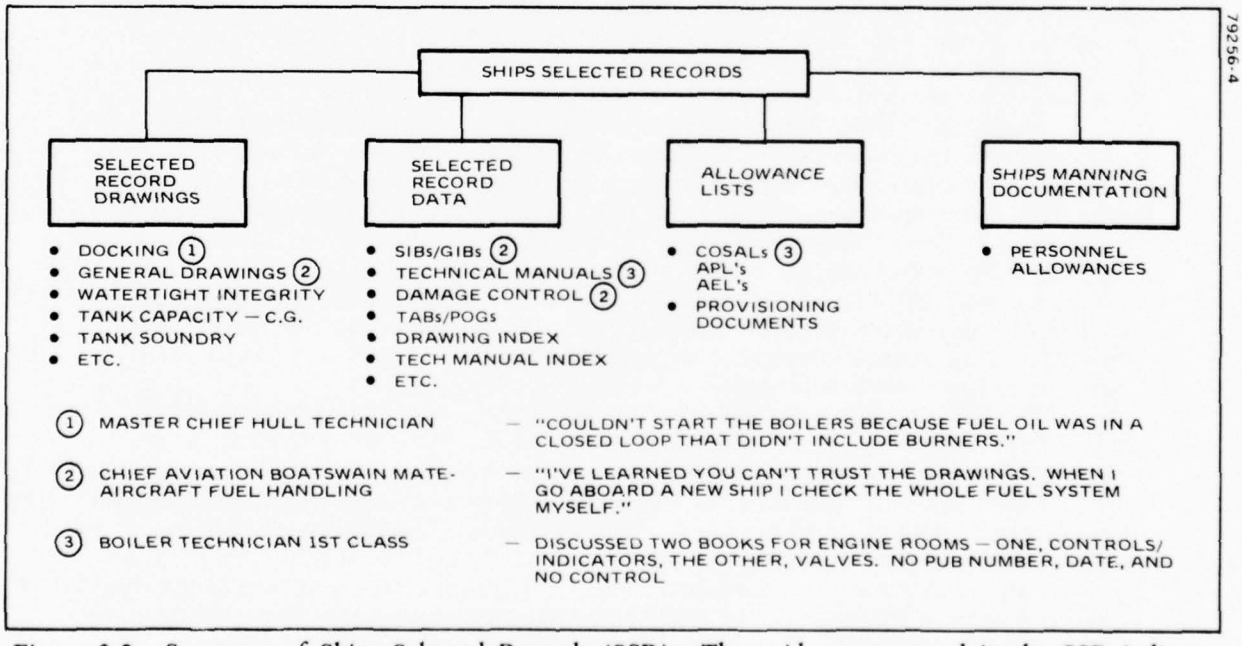

Figure 3-2. Structure of Ships Selected Records (SSR). The voids encountered in the SSR indicate that the funds expended are not resulting in commensurate data value to the user community.

3.2.7 SUPPLEMENTARY DATA: ENGINEERING OPERATION SEQUENCE SYSTEM (EOSS)

The need for system-level MOTD is indicated by the evolution and use of Engineering Operation Sequence System manuals, a "patch" for severe data problems. EOSSs are an excellent example of MOTD which is user-data-matched to the benefit of the user and to the readiness of the 1200-psi propulsion system.

Engineering Operation Sequence System (EOSS) manuals are MOTD for operators in propulsion group jobs for ships with 1200-psi propulsion plants. The data is presented in clear, concise, step-by-step procedures, with system-level block diagrams and generalized specifications data used to augment the user's understanding of the procedures. There are two categories: Engineering Operating Procedures (EOPs) and Engineering Operating Casualty Control (EOCCs). The EOPs provide normal operating procedures, whereas the EOCCs provide damage control and fault isolation procedures for a malfunctioning system.

Survey responses from interviewees in the engineering ratings indicated that a disparity existed in operational data found on the various ships visited. This was not anticipated prior to the survey, and no questions had been directly addressed to distinguish or measure this category of problem. However, as the interviews progressed, probing in areas related to propulsion equipment led to the awareness that a problem existed. The matter was partially clarified when an interviewee brought the Engineering Operation Sequence System (EOSS) manuals to an interview as a sample of good MOTD. This led to a visit to the Pacific Propulsion Examining Board.

The avenue by which these manuals have come into existence remains unclear to the survey team. It is very difficult to resolve the similarities between EOSSs as produced, and Propulsion Operating Guides (POGs) as they are supposed to be produced. The POGs are part of the Ships Selected Records, but their application does not seem to be well specified or controlled. There is no apparent update process for these books, at least in practice. The EOSSs appear to be a "patch" over a serious MOTD shortcoming stemming from shipyard's lackadaisical approach to documentation. (See Table 3-11.)

The visit to the Propulsion Examining Board resulted in an interview with two Commanders who provided the following information: The history of EOSS manuals was described as originating in a low equipment-readiness rate aboard ships with 1200-psi propulsion plants. A project office was set up to investigate the problem. The problem was found to be a matter of inadequate training and a high turnover rate among personnel assigned to operate the 1200-psi plants and a lack of adequate MOTD. A set of EOSS manuals was produced using techniques successfully demonstrated with nuclear power plant manuals. The latter have proven to be an excellent example of matching the user's needs and equipment characteristics to technical data.

The fleet applications observed by the survey team, and in accordance with a directive of the Propulsion Examining Board, were to provide an EOSS manual at each watch station. This provides day-by-day usage, increases familiarity of the user with this data, and has resulted in a measurable improvement of equipment readiness and personnel effectiveness. The personnel effectiveness measure was provided by tying the EOSS manuals to the Personnel Qualification System, and noting the improvement. The Propulsion Examining Board members were very high in their praise of EOSS manuals, and stated that the technique was to be applied to other classes of propulsion equipment in the future. There is also a growing awareness that the 600-psi equipment MOTD only appeared to be adequate, while in fact the real difference was in the relative complexities of the

two classes of equipment. The feeling is that the maintainers had masked the MOTD inadequacies by using initiative and experience. As equipment complexity increases (i.e., as more electrical/electronic control is applied) this group of maintainers must be supported by better MOTD than has been customary.

A point of interest to this survey is that providing system-level technical data resulted in a significant increase in effective utilization of personnel and a measurable increase in equipment readiness. A definite need for system-level data exists throughout Navy ships' systems, and has gone largely unanswered.

A second point to be made is that these manuals satisfy the needs of a group of operators. The general survey results showed that maintainers usually have barely adequate technical data to perform their job, whereas operators rarely have adequate technical data coverage. The operation procedures provided in the usual technical manual are provided for the maintainer's use in turn-on, turn-off, and checkout procedures, and do not address the on-the-job needs of operators.

TABLE 3-11. EOSS FACTORS

Problem	– 1200-psi Propulsion Plant showed low readiness
Why?	– Inadequate training – High personnel turnover – Inadequate MOTD – Equipment complexity increase
Problem Study	– Set up Program Office – How does nuclear-Navy do it? – Use MOTD to solve
EOSSs	– Provide system-level MOTD – Operator-oriented – Can be unique for each ship – Matches PQS use
Results	– Personnel more effective – Equipment readiness improved – Pointed up weakness in POGs and the other applicable MOTD
Questions	– Where do EOSSs fit in the MOTD system? – Who controls the application? – What happens to POGs (vs. EOSSs)?

3.3.1 ACCURACY: PROBLEMS AND IMPACT ON USER

Technical manuals are put into fleet and training use with technical errors, inadequate data and missing data. User confidence is severely shaken, maintenance performance suffers, and equipment readiness rates are often lowered.

The survey interviews brought an apparent quality control problem to the surface. Pursuit of this problem in numerous interviews showed the problem to occur in both descriptive and procedural data. The inaccuracies were commented upon nearly equally by members of training, aircraft, and shipboard communities. The magnitude of inadequate and missing data appears to be markedly greater for shipyard-designed and installed equipment (as opposed to contractor-furnished equipment).

Descriptive data problems exist in the general description section and in theory of operation sections of various technical manuals. The descriptive data is used frequently on the job by the mechanical ratings, and the level of complaint is quite high. The degree of inaccuracy was not anticipated when the questionnaire was designed; therefore, the problems surfaced under the "too little" category or as difficulties in comprehension levels. The direct, structured interview technique allowed the underlying causes of these complaints to surface and the problems to be further defined. Comments in the Description of Equipment area were typically:

(1) "Writing is vague because writer assumes too much,"
(2) "Vague descriptions,"
(3) "Varies with the equipment."

This area is used for training and general reference by most users, and for specific on-the-job reference by mechanical ratings.

Comments in the Theory of Operation area were about the same. Approximately one-third felt there was too little coverage. Typical comments in this area were:

(1) "Description contradicts itself; flow is wrong"
(2) "Inaccurate, out-dated, does not reflect current equipment"
(3) "It is obvious that writer does not understand"
(4) "New TMs sometimes are not right."

These sections of technical data receive two primary uses – training and troubleshooting or repair. The training use is obvious, and complaints were in the areas of inadequate coverage, missing coverage or inconsistent coverage (e.g., an amplifier is explained in detail but a frequency generator is given the briefest of coverage within the same technical manual). The instructors cannot use technical manuals with these deficiencies without considerable re-writing and producing of training guides or aids. The maintainer and operator use these sections for job performance in repair or troubleshooting circumstances – the worst possible time to uncover technical data problems.

Procedural data was criticized in a strong manner. Typical comments were:

(1) "Usually do not produce results"
(2) "Do not find the actual equipment faults"
(3) "Get little use by senior techs; not adequate for an operator"
(4) "Hard-to-fix equipment has the least data"
(5) "The contractor is going too light in operations for techs to use"
(6) "The ones (faults) that happen are not the ones covered"

In many instances, procedural data did not work. The coverage is often inadequate in operations sections for maintainers. The operations data

(i.e. for operators) is generally inadequate where it exists, and is normally covered so lightly that it must be produced aboard the respective ships. Maintainers were quite insistent about the need for troubleshooting data which worked and addressed the faults which really occur. The complaint of troubleshooting procedures being too short was recorded in 44% overall, and by 40% to 53% in the different categories (see Table 3-12). The need for improvement was seen by 44% overall, and varied from 42% to 50% within the categories. This was one survey result which was particularly consistent in findings and even more pronounced in the degree of certitude expressed by the interviewees. One group which is not apparent in the findings is composed of those technicians who stated that the "procedures are probably okay. I do not really know because I do not use them, I just use the schematics and theory" (for electronic/electrical ratings) or "I just use the drawings and description for tolerances" (for the mechanical ratings). These maintainers were not counted, but they did form a sizeable group.

An area of complaint not anticipated in the formative stages of the survey is that resulting from the documentation in support of shipyard-designed and installed equipment. In the conduct of interviews aboard the USS CONSTELLATION, emphasis was given to weapon elevators at the behest of CDR Rein of COMNAVAIRPAC, as this system has been identified as having a chronic lack of readiness. The system was found to be extraordinarily hard to support because of technical data which was missing, inadequate, and out-of-date. There are six weapons elevators aboard this ship. These elevators were shipyard-designed and installed, but the technical data support appears to be produced without conformance to the normal quality control functions. This same type of problem appeared with catapult troughs. As a result, this area (shipyard-designed and installed equipment MOTD) was followed up throughout the remainder of the survey.

3.3.1 ACCURACY: PROBLEMS AND IMPACT ON USER (Continued)

On the USS JOUETT (CG29), a similar complaint was expressed by those interviewees responsible for missile system maintenance. The equipment used to move the missile from the preparation area to the position for loading onto the launcher rail was shipyard-designed and installed. No technical manuals or instructions relevant to maintenance requirements were provided by the shipyard. This equipment has failed frequently during operational use. Missile system maintenance personnel perform the corrective maintenance without MOTD support. Difficulties and problems are usually solved by the expertise of the senior petty officers, but the Mean-Time-To-Repair is increased. This is a serious problem as it impacts the readiness condition of the missile system which is vital to this ship's prime mission (i.e., to protect carriers in wartime situations).

On the USS KINKAID (DD965) a complaint was voiced concerning the lack of documentation needed to support maintenance on the 5" 54 ammunition hoists. The maintenance personnel perform maintenance without maintenance documentation. They feel that adequate MOTD support was a shipyard's responsibility and should have been provided.

TABLE 3-12. SURVEY RESULTS RELATED TO ACCURACY PROBLEMS AND IMPACT ON USERS

Area of Coverage	Overall Results	Electronic Ratings	Electro-Mechanical Ratings	Mechanical Ratings
Descriptions:				
Too little	28%	20%	25%	46%
Used on job	71%	65%	74%	76%
Theory:				
Too little	35%	39%	32%	33%
Diagrams not accurate	30%	25%	26%	39%
Used on job	81%	86%	77%	79%
Procedures:				
Operations too short	10%	11%	10%	10%
PMS too short	18%	12%	16%	28%
Troubleshooting too short	44%	40%	43%	53%
Troubleshooting need improvement	44%	50%	43%	42%

3.3.2 UTILITY AND COMPREHENSION BY USER

Twelve percent of all respondents (up to 20 percent in the mechanical ratings) have difficulty with the technical level and/or writing level in their MOTD. These respondents feel that this difficulty results both from the inherent reading level and from the lack of standardization in format, terminology, and presentation technique.

Problems associated with comprehension of reading material often derive from a mismatch which occurs between the reading level (or ability) of an individual and the level at which the written material is generated. Simply put, this means that if you want someone to understand what you give them to read, the material must be written at their level.

It has become increasingly apparent, however, that the gap is widening between the reading ability of the technician/trainee in the military, and the level at which the technical data contained in manuals is written. Powers[3] reports that half of the Navy recruits tested during fiscal year 1975 read below a 10.7 RGL; that is to say well below the level expected of a high school graduate. In anticipation of that situation becoming even more acute, the Army has established that in the development of technical manuals and training materials through their Improved Technical Documentation and Training (ITDT) programs, materials will be developed so as to be suitable for presentation to individuals having a reading ability at the fifth grade level.

The results of the present survey lend support to the importance of this aspect of an MOTD mismatch. While percentages vary according to how information is grouped (e.g., by rating, by occupational specialty, by maintenance level, etc), it was found that a substantial portion of those individuals surveyed expressed concern over the "understandability" of the material in the tech manuals. In expressing their concern to the survey team, statements such as "the book is written for engineers; we are only sailors" were frequently encountered.

Table 3-13 presents the results of survey questions which relate specifically to the issue of the "readability" or "understandability" of material as presented in the technical manuals. It will be noted that for purposes of comparison, the survey sample is divided into three categories. These categories correspond to rates which are primarily concerned with electronic, electromechanical, and mechanical ratings. These are compared with a composite which consists of the entire 427 Interview survey sample. Notable findings here include the following:

(1) While the majority of the individuals felt that the technical level of the Description section of the TM is about right, a relatively high percentage (21%) of the mechanical rating personnel felt that it is "too hard."

(2) Concerning the writing, nearly 20% of all individuals felt that it is confusing, and this feeling is highest (approximately 24%) among mechanical rating personnel.

(3) The technical level of the Theory section is characterized as too hard by 18% of the entire sample and 26% of the mechanical rating personnel.

(4) Combined deficiencies in clarity and logic were expressed by 25% of the entire sample.

(5) Sixteen percent of the overall sample said that the writing in the Theory section is too hard, and again the feeling is most pronounced among mechanical rating personnel (25%).

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[3] Powers, Thomas E., Navy Enlisted Personnel Characteristics, ManTech Corporation of New Jersey, June 1976, pp iii, 2-3.

Finally, in discussing the utility of the tech manuals beyond the issue of understandability, personnel interviewed expressed a strong concern over the lack of standardization among the manuals. This concern encompassed the standardization of format, presentation technique, and terminology. As an example, members of the survey team were shown instances in which manuals had been developed by two different contractors for the same type of equipment. Both contractors were working to the same specifications; theoretically, there should have been a marked degree of similarity between the two manuals. However, this was not found to be the case. Rather, the two manuals provided an effective illustration of the lack of standardization which precipitates a great deal of confusion among their various users. Some of the interviewees expressed the opinion that just "learning how to use the (different) books" can be a formidable undertaking. This can greatly diminish the effectiveness of the technician in the performance of this job.

TABLE 3-13. RESPONSES INVOLVING MOTD COMPREHENSION BY THE USER

Area of Inquity	Response	Electronic Group	Electro-Mechanical Group	Mechanical Group	Composite
Is the technical level (of the Description of Equipment Section):	Too Simple	8%	8%	7%	8%
	About Right	72%	69%	62%	68%
	Too Hard	9%	9%	21%	12%
	No Response	11%	14%	10%	12%
What about the writing (of the Description of Equipment Section)? Is it confusing?	Yes	17%	20%	24%	20%
	No	9%	10%	10%	9%
	No Response	74%	70%	66%	71%
Is the technical level (of the Theory Section):	Too Simple	10%	4%	6%	7%
	About Right	65%	64%	56%	62%
	Too Hard	12%	19%	26%	18%
	No Response	13%	13%	12%	13%
Does this section (Theory) seem clear and logical?	Yes	58%	62%	64%	61%
	No	23%	21%	19%	21%
	Clear, but not logical	2%	1%	3%	2%
	Logical, but not clear	1%	3%	2%	2%
	No Response	16%	13%	12%	14%
Is the Writing (in the Theory Section):	Too Simple	5%	3%	1%	3%
	About Right	72%	66%	63%	68%
	Too Hard	10%	18%	25%	16%
	No Response	13%	13%	11%	13%
Total Number of Personnel Responding:		173	134	107	427

3.3.3 MOST-USED AND LEAST-USED SECTIONS

All types of data conventionally included in technical manuals were not reported to be equally necessary, or even helpful, to the technician during any given maintenance activity. Some would like these to be kept in separate reference volumes rather than burden the technician with data not needed while performing maintenance tasks.

The interviewees felt that reducing MOTD bulk could do much to improve its utility from the standpoint of ease of handling. Many of the individuals surveyed indicated that there are substantial amounts of data contained in the manuals which are rarely used during the performance of routine maintenance activities. They stated that, when feasible, this data be extracted from the main body of the manual and be published as separate reference volumes. Responses to questions on the survey, as well as direct conversations with users, indicated that large portions of certain sections, or even entire sections, could be consolidated into reference manuals.

Table 3-14 presents a summary of responses concerning the most and least used sections of the tech manuals. The responses are grouped according to three categories of ratings: electronic, electro-mechanical, and mechanical. These responses are compared with a composite which is based upon the entire survey sample. The data presented indicate the following:

1. The most-used sections of the manual are Theory, Procedures (all types), and Diagrams.
2. A comparison of the responses to the two questions suggests that possible candidates for inclusion in the reference volumes (mentioned above) are the Description, Installation, and Parts Lists sections.

While the information contained in all sections of the tech manuals may well be of value for certain purposes, the respondents do not necessarily believe that all of it is required, by everyone, all of the time.

TABLE 3-14. RESPONSES INVOLVING MOST-USED AND LEAST-USED PORTIONS OF MOTD

Inquiry	Response	Electronic Group	Electro-Mechanical Group	Mechanical Group	Composite
What parts of the technical manual do you use the least?	Description	43%	43%	26%	39%
	Theory	9%	7%	24%	12%
	Procedures	9%	11%	8%	9%
	Installation	11%	6%	4%	7%
	Parts Lists	3%	4%	6%	4%
	Diagrams	3%	3%	2%	3%
	No Response	22%	26%	30%	26%
What parts of the technical manual do you use the most?	Description	4%	3%	7%	4%
	Theory	28%	21%	7%	20%
	Procedures	27%	32%	39%	32%
	Installation	0%	1%	0%	0%
	Parts Lists	5%	14%	9%	9%
	Diagrams	23%	15%	26%	21%
	No Response	13%	14%	12%	14%

3.3.4 ILLUSTRATION TECHNIQUES: EFFECTIVENESS AND USER PREFERENCES

The survey found that illustrations in MOTD convey intended meanings to a majority of users, but not for a significant minority, and many feel more are needed. The printed book is the predominantly favored medium for illustrations.

The survey found that 58.7% of the composite group feel that the MOTD illustrations are accurate and easily understood with the range varying from 63% of electronic rates as the high and 51.4% of the mechanical rates on the low end. This leaves a composite group of 29.5% who do not feel the MOTD illustrations are accurate or easily understood. The electronic ratings response of 25.4% compared with the mechanical ratings 39.2% shows a problem exists for all MOTD user classes, but is more pronounced for the mechanical ratings. The composite 29.5% result shows a major problem for a significant number of MOTD users. The higher 39.2% result for the mechanical ratings probably results from the problem set found with shipyard-produced MOTD referred to throughout this report. Figure 3-3 indicates a striking example.

The question of MOTD illustrations being clear showed very similar results to that noted above. Once again, the results showed the best communication occurs with the electronic ratings MOTD and the greatest degree of problems occurring with the mechanical ratings MOTD.

The question concerning the quantity of illustrations supplied in MOTD followed the same pattern as above. The consistency of these responses indicates that while the mechanical ratings seem to be served most poorly by their MOTD, the results for the other two rating groups show responses in numbers sufficiently large to indicate an overall, illustration problem.

The illustration types preferred by the rating groups are indicative of the equipment they work on. Electronic rating responses favor schematics (47.9%) and block diagrams (24.8%) which serve best to illustrate electronic equipment operation. The electro-mechanical rating responses favored schematics most (32.8%) which is approximately equal to the number of ratings in the group who work with electrical equipment. The second choice was block diagrams (16.4%) which works for electronic equipment but is less effective for electrical equipment such as power distribution circuitry, etc. The third choice was a near equal selection of photos (10.4%), blueprints (11.9%) and combinations (10.4%) which favors the mechanical members of the rating group. The mechanical rating group indicated a marked preference for blueprints (40.1%). This provides the best form of illustration data for machinery.

The subject of illustration media shows a marked preference for printed books. The electronic ratings showed the strongest preference for books (72.2%) with the corresponding least preference for microform (9.2% when compared with book and only 3.4 when asked as "use of microform" alone, as shown in Table 3-15.) The electro-mechanical ratings responded at the rate of 65.6% in favor of books compared with 17.9% favoring microform. The acceptance of microfilm only (not compared with other media) showed an acceptance by 11.9%. The mechanical ratings responded 62.6% favoring books and 14% in favor of microform in the comparison quering. In the non-compare question, 20.5% would accept illustrations on microfilm. The above should be evaluated with the material presented in mind. Electronic illustrations tend to be more than one page frame long and contain much detail. Mechanical drawings are more often contained on single pages.

The overall findings show the interviewees have problems with illustrations in numbers too large to overlook. These findings present a problem which needs evaluation and solution.

TABLE 3-15. RESPONSES INVOLVING ILLUSTRATION TECHNIQUE EFFECTIVENESS AND USER PREFERENCES

Query	Response	Electronic (%)	Electro-Mechanical (%)	Mechanical (%)	Composite (%)
Are the diagrams accurate, easy to use, and easy to understand?	Yes	63.0	61.1	51.4	58.7
	No	25.4	26.1	39.2	29.5
	No response	11.5	12.6	9.3	11.7
Are the pictures and diagrams clear?	Yes	66.4	63.4	47.6	60.6
	No	16.1	26.8	42.0	25.7
	No response	17.3	9.7	10.2	13.5
In your opinion, are there TOO FEW, ENOUGH, TOO MANY diagrams, pictures, and drawings?	Too few	29.4	45.5	53.2	41.2
	Enough	55.4	41.0	27.1	42.8
	Too many	3.4	2.9	10.2	4.9
	No response	11.5	10.4	9.3	11.0
Which of these gives you the most information?	Photos	2.8	10.4	7.4	6.5
	Line drawings	2.8	8.9	13.0	7.4
	Blueprints	1.7	11.9	40.1	14.5
	Block diagrams	24.8	16.4	13.0	18.7
	Schematics	47.9	32.8	11.2	33.7
	Combinations	8.6	10.4	3.7	7.9
	No response	10.9	8.9	11.2	11.0
Which sections of the tech manual would you like to see on microfilm?	Description	15.0	12.6	7.4	12.1
	Theory	5.7	1.4	4.6	3.9
	Procedures	4.0	4.4	2.8	3.9
	All sections	16.7	8.9	6.5	11.4
	No sections	24.2	21.6	21.4	22.9
	Diagrams	3.4	11.9	20.5	10.5
	Parts lists	14.4	14.9	19.6	15.6
	No response	16.1	23.8	16.8	19.2
How would you like to see (schematics, diagrams, etc) presented?	Book	72.2	65.6	62.6	67.2
	Microfilm	9.2	17.9	14.0	13.1
	Audio/visual	0.0	4.4	3.7	2.3
	CRT	2.8	2.2	3.7	2.8
	Other	1.7	0.0	0.9	0.9
	No response	13.8	9.7	14.9	13.5

Figure 3-3. Foldout from Weapons Elevator MOTD. Print is barely legible, some 15 feet long, and mismatched to use in cramped aircraft carrier elevator shaft.

3.4 USE OF MOTD IN FORMAL AND INFORMAL TRAINING

The printed manual is generally the user-preferred medium for a training application, but there are problems concerning accuracy, comprehensiveness, and understandability which impede its effectiveness as a training aid.

The findings concerning the use of MOTD in training can be divided into two broad categories: those obtained from the survey questionnaires and those derived from the comments of Navy personnel during interviews. Table 3-16 presents the responses to those survey questions which bear on the subject of training. The responses are categorized as to the role of the technical manual user: Instructor, Technician, or Operator. These responses are compared with a composite which represents the responses of the entire survey sample. The findings from the survey questionnaire are as follow:

1. Important, from a training perspective, is the ability of the student to clearly understand the material which is presented to him. This was found to be a problem both in the areas of the text and in the accompanying illustrations. The particulars concerning these problems are presented in Topic 3.3.2 and will not be recounted here.
2. Technical manuals are used in approximately 75% of formal training courses as indicated by those individuals surveyed. However, these technical manuals are not used without the instructor having to prepare supplemental handout material to be used in conjunction with the manuals. Though no quantitative values were obtained, it was felt subjectively by the individuals surveyed that the amount of supplemental material necessary was substantial.
3. Preferences for and against having personal sets of technical manuals during training are approximately evenly distributed. Further, a comparison of responses on this issue indicates that the individuals in the survey feel there to be relatively more disadvantages than advantages associated with possessing their own set of manuals. It can be noted here that the primary advantage seen by these individuals in having their own set of manuals is the ability to personalize them by adding marginal notes and supplemental data. The primary disadvantage cited was the added burden of having to maintain their manuals in an up-to-date condition. Approximately 53% of the overall sample felt that having to update the manuals would be bothersome.
4. Related to the factor of having to update the technical manuals, it is interesting to note the disparity among groups of individuals concerning the issue of whether the manuals are in fact kept up-to-date. Overall, the feeling is nearly two-to-one that the manuals are current. However, it should be noted that it is predominantly the instructors (82%) who feel this is the case. The feeling among those who could be classified as "users" is substantially to the contrary. 32% of the technicians and 51% of the operators feel that the manuals are not kept up-to-date.
5. Regarding the preferred medium for presenting the materials in training, it is still the printed technical manual which has the greatest overall acceptance. The first two questions in Table 3-16 are exemplary in their representation of the preference of printed manuals over various other forms of media.

6. In addition to the technical manuals, it was noted that those surveyed felt that at least some of the materials obtained in training, as well as their own supplemental material, are required in the performance of their job. This is predominantly the case for both technicians and operators.

Additional training-related findings derived from the interviews conducted during the survey are as follow:

1. In formal training, the technical manuals are used essentially as textbooks, and as such are intended to function as primary sources of training information. It was felt by many of those interviewed, however, that the data contained in the manuals is frequently inaccurate.
2. There is wide use of a multimedia approach to training during formal training. For OJT, however, the technical manual is the most prolific and expedient medium. This distribution of media is, however, largely dictated by the constraints of the field environment. This is to say that the technical manuals are simply the most expedient medium for use in the field, mainly due to the considerations involving the reliability and portability of other forms of media.
3. During formal training, coverage of the various sections of the technical manual is fairly uniform. In practical application, however, certain sections of the manual are used much more frequently. As can be seen from Table 3-16, the Procedures and Theory sections are used the most on the job.

3.4 USE OF MOTD IN FORMAL AND INFORMAL TRAINING

TABLE 3-16. RESPONSES INVOLVING USE OF MOTD IN TRAINING

Question	Response	Instructor (%)	Technician (%)	Operator (%)	Comp (%)
This section (Description) is best learned by...	Audio	0.0	4.5	0.0	2.1
	Film	25.8	16.0	14.2	15.4
	Combination	27.5	24.5	48.9	29.5
	Book	29.3	46.2	32.6	37.7
	No Response	17.2	8.5	4.0	15.2
This section (Theory) is best learned by...	Film	8.6	26.2	28.5	22.9
	Slides	12.0	8.0	12.2	7.9
	Audio	1.7	1.7	2.0	1.8
	Book	65.5	52.0	53.0	51.7
	No Response	12.0	12.0	4.0	15.4
What parts of the tech manual do you use the least?	Description	29.6	45.7	28.5	38.4
	Theory	5.1	13.1	16.3	12.4
	Procedures	22.4	8.0	12.2	9.1
	Installation	8.6	5.7	14.2	7.4
	Parts Lists	5.1	4.0	6.1	4.2
	Diagrams	0.0	4.0	4.0	2.5
	No Response	18.9	19.4	18.3	25.7
What parts of the tech manual do you use the most?	Description	10.3	2.2	2.0	4.2
	Theory	48.2	16.5	26.5	20.1
	Procedures	13.7	41.7	30.6	31.3
	Installation	0.0	0.0	0.0	0.2
	Parts Lists	5.1	9.1	8.1	9.1
	Diagrams	12.0	23.4	26.5	21.0
	No Response	10.3	6.8	6.1	13.8
Did you use tech manuals in your training course?	Yes	86.2	84.0	69.3	75.8
	No	3.4	5.1	18.3	8.6
	No Response	10.3	10.8	12.2	15.4
Did the instructor give you handout sheets?	Yes	81.0	84.5	77.5	78.2
	No	5.1	5.1	4.0	4.9
	No Response	13.7	10.2	18.3	16.8
What materials from your training course do you use on the job?	Some	74.1	55.4	63.2	57.3
	None	15.5	32.5	18.3	24.8
	No Response	10.3	12.0	18.3	17.7
Have you added material or information of your own for use on the job?	Yes	68.9	61.7	73.4	59.0
	No	24.1	21.7	12.2	22.7
	No Response	6.8	16.5	14.2	18.2
Would you like to be given your own set of tech manuals at the beginning of training?	Yes	43.1	47.4	55.1	44.7
	No	48.2	41.7	34.6	40.5
	No Response	8.6	10.8	10.2	14.7
Would you like to be given your own set of tech manuals at the beginning of OJT?	Yes	25.8	28.5	40.8	27.8
	No	34.4	21.7	30.6	25.2
	No Response	39.6	49.7	28.5	46.8

TABLE 3-16. RESPONSES INVOLVING USE OF MOTD IN TRAINING (Continued)

Question	Response	Instructor (%)	Technician (%)	Operator (%)	Comp (%)
What would be the advantages of having your own set of tech manuals?	Some	50.0	52.0	57.1	48.9
	None	15.5	13.1	14.2	13.8
	No Response	34.4	34.8	28.5	37.2
What would be the disadvantages of having your own set of tech manuals?	Some	74.1	66.2	51.1	63.4
	None	5.1	8.0	16.3	8.1
	No Response	20.6	25.7	26.5	28.3
Would changing pages and updating the manual bother you if you had to do all the updating?	Yes	62.0	48.0	67.3	53.3
	No	18.9	28.5	20.4	23.6
	No Response	18.9	23.4	12.2	22.9
Are the tech manuals kept up-to-date?	Yes	82.7	60.5	38.7	59.0
	No	12.0	32.0	51.0	28.5
	No Response	5.1	7.4	10.2	12.4
Total Individuals Responding		58	175	49	427

3.5.1 IMPACT AND HANDLING OF MOTD CHANGES

MOTD update inadequacies present a serious problem for MOTD supporting shipyard-designed and installed equipment and old equipment. Operations and maintenance job performance are adversely effected by the lack of current MOTD.

Equipment alterations are made to correct hardware deficiencies or to improve performance. MOTD must also be updated to reflect such alterations, to enable the operator and/or maintainer to perform his job effectively. Modifications performed by contractors include provisions for MOTD update, including review and buyoff of the updated material. Modifications and ship alterations performed by shipyards are also supposed to include the full MOTD update review and buyoff, but quite often do not. (See Table 3-17.)

The lack of updated MOTD for shipyard-designed and installed or modified equipment came to light in the early stages of the survey. Weapons elevators aboard the USS CONSTELLATION were identified as a system which had readiness problems that were found to be largely related to trying to maintain equipment without adequate MOTD. The interviewees had technical data with a 1960 publication date, and no subsequent update. This was for an elevator which had undergone numerous modifications in shipyards and no longer resembled the data provided. This incident flagged an area of interest which was watched throughout the remainder of the survey.

The problem surfaced in another form at Miramar NAS where technical manuals approximately six years old were still labeled "Preliminary." The maintainers stated that even though they had received changes to these preliminary manuals, they felt a lack of confidence in this data. The degree of complaint in this area was more subdued and less frequent than for the shipyard-designed and installed equipment MOTD.

An area of consistent complaint was the bothersome aspects to incorporating changes received into the existing MOTD. This task is considered to be both unpleasant and extremely costly in terms of man-hours. The shore-based users normally have this task taken care of through a Technical Library and/or Quality Control function which provides a check of the overall unit's MOTD state of currency. The task appears to be a little more palatable, since changes or delivery of changes occur over a reasonable period of time. A different matter occurs with ships. They find changes sitting on the pier awaiting their return. One maintenance officer stated that everytime the ship came in they picked up boxes of changes. One man was assigned full-time to incorporating the changes into the MOTD when the ship was at sea. He had found this method to work best with respect to guaranteeing that the MOTD was kept up-to-date. He expressed a need for a better system, but did not have any suggestions for accomplishing this. Microform was pointed out as a medium which eased the update problem, but he said he would rather have the update problem, than lose the printed manuals.

In the survey response, an overall group of 28.5% felt their MOTD was not kept up-to-date; the reason given was that the update material was not available. More significantly, within the mechanical ratings (who are the primary maintainers of shipyard designed equipment) only 37% felt their MOTD was up-to-date, and 52% felt it was not. This contrasts with the 26% in the

electro-mechanical rating category and the 17% in the electronic ratings who feel their MOTD is not up-to-date. This contrast is highlighted when it is considered that the latter two categories use little shipyard-designed equipments; rather, most of their equipment is furnished by contractors who are subject to the subsequent control cycle exerted over supporting MOTD.

TABLE 3-17. UPDATE PROFILE WITH RESPECT TO JOB CATEGORIES AND BY INFERENCE TO MOTD PRODUCED BY SHIPYARDS, AS OPPOSED TO THAT ACQUIRED THROUGH SYSCOM-CONTROLLED CONTRACTOR SOURCES

Query	Composite Group	Little Shipyard MOTD		Mostly Shipyard MOTD
		Electronic Categories	Electro-Mechanical Categories	Mechanical Categories
• Are your manuals:				
Kept up-to-date:	59%	70%	62%	37%
Not kept up-to-date:	29%	17%	26%	52%
No opinion	12%	13%	12%	11%
• Is update incorporation:				
Bothersome?	53%	54%	50%	56%
No problem?	24%	24%	30%	17%
No opinion	23%	22%	20%	27%

• Missing data reported on:
USS CONSTELLATION (CV 64) Weapon Elevator
USS CONSTELLATION (CV 64) Catapult Troughs
USS JOUETT (CG 29) Missile Handling Equipment

3.5.2 USER-GENERATED CORRECTIONS AND FEEDBACK

Survey findings indicate that, with the exception of PMS data, the feedback system is rarely responsive. The MOTD user feedback system needs improvement to make the feedback reaction positive and timely.

MOTD users have a specified system by which they may feed back corrections to errors found in their data, provide improved methods for accomplishing a task, and provide any response to the system that they feel is appropriate. Although the provisions exist, the usage rate is low, varying from 20% to 50%, depending on rate category. These response numbers are possibly more favorable than the actual performance by the user. It was discovered during the conduct of the survey that the question: "Do you write up errors you find in the tech manuals?" was quite often answered "yes" but probing turned up the fact that many were considering the addition of pen or pencil corrections (to their own and the shop manuals) as response enough to be a positive answer. Even with this biasing factor, those who declared that they do not participate in the feedback process form a large group.

Those who stated they did not utilize the feedback system were asked "why?" The responses fell into two groups. One group said it was simply too much trouble, in view of the paperwork load they already had. The second group, which also included some from the first, said that they received little or no response in the past, and hence did not bother. This is shown in Table 3-18 as being from 16% to 29% of the total respondents who noted no acknowledgement of their input to the feedback system. The "No response" category was particularly large ranging from 37% to 50%. This group consisted largely of those who do not participate in feedback in the first place, but were augmented by some who did not realize a response was part of the system. Many from all groups stated that any response to feedback was extremely slow, and they did not see much value to a system with such a long response time or (even worse) one which does not respond at all.

Some users felt they were constrained against providing feedback written against preliminary technical manuals, on the assumption that errors would be recognized and taken care of in the final manual. A few respondents indicated that they had been told this by a reply to a submittal and had quit submitting errors as a result. However, in-use preliminary technical manuals that were as much as six years old were shown to the survey team. This was a source of disturbance to the users, in that they felt that preliminary data implied a certain amount of allowable inaccuracy and lack of complete development.

One interviewee stated that whenever he really wanted a response to a particular MOTD problem, he would characterize the MOTD deficiency as a safety problem and address it to the home port Safety Officer. He stated that he always got a response and always received the response in a very timely manner.

The one bright point in the feedback system is the effectiveness exhibited by the PMS feedback system. Nearly all interviewees who were asked about PMS feedback replied that they get good answers in a reasonable amount of time. The control and management of this facet of the feedback system is outstanding in recognizing the needs of the user, and as a result is used extensively.

TABLE 3-18. RESPONSES INVOLVING FEEDBACK

Question Area	Total Group	Electronic Rates	Electro-Mechanical Rates	Mechanical Rates
• Respondent usually				
– Documents errors found in manuals	58%	65%	61%	40%
– Does not document errors found	30%	20%	28%	50%
– No response	13%	15%	11%	9%
• Action is				
– Taken on documented errors	40%	46%	46%	21%
– Not taken on documented errors	21%	20%	16%	29%
– No response	39%	34%	37%	50%

3.6 MOTD USE IN PREVENTIVE MAINTENANCE SYSTEMS

The Planned Maintenance System (PMS) is the primary preventive maintenance guide used to attain and maintain operational readiness and efficiency of equipments and systems. PMS has effectively superseded the manufacturer's requirements usually found in MOTD as periodic maintenance procedures, and is strongly preferred by users over those MOTD procedures.

The Planned Maintenance System was developed to provide ship and aviation activities the means to effectively plan, schedule, and control maintenance. PMS procedures reduce complex maintenance to simplified preventive procedures, and serve to control preventive maintenance in scheduled phasing. The PMS system aids planning of manpower and material requirements, and detects areas requiring additional emphasis on training and performance techniques. Some of the major benefits attained from PMS were stated to be: (1) increased reliability, (2) increased economy, (3) better planning, (4) better records, and (5) improved leadership and management.

Effective PMS depends upon proper utilization of certain management tools within the system. These include Maintenance Requirement Cards (MRCs), Maintenance Index Pages, Periodic Maintenance Requirements Manuals (PMRM) and schedules for the accomplishment of preventive or periodic maintenance actions. The MRCs and Maintenance Index Pages are validated for the specific ship equipments/systems when the system is installed. They are "tailored" for that individual ship.

MRC Cards – The Maintenance Requirements Cards define the preventive maintenance job in terms which provide the worker with a detailed step-by-step procedure for best accomplishing the job. Tools, equipment and materials required are listed along with safety precautions. The required rating man-hours are listed. This helps the supervisor in maintenance management planning.

PMS Users – The personnel who perform PMS are maintainers, maintainers/operators, and operators. The survey found that much of the preventive maintenance is done by non-rated and/or junior operators and maintenance personnel. In addition, the senior petty officers use the PMS to conduct training, especially on the job training and PQS (Personnel Qualifications Standards) training.

Preventive and Periodic Maintenance – This information is found in most technical manuals. Preventive maintenance is scheduled maintenance in which tasks are known in advance, and can be included in a monthly maintenance plan and is usually associated with the PMS system. Periodic maintenance is also scheduled maintenance primarily used by aviation maintenance personnel guided by the calendar inspection system. These maintenance requirements and inspections are found in the Periodic Maintenance Requirements Manuals which is a component of the PMS system.

MOTD Periodic Maintenance Procedures – During the survey, opinions were obtained concerning periodic maintenance procedures in MOTD. The intent was evaluation of those procedures to determine if they are too long, about right, or too short. The results for three occupational specialty groups as well as the total group are shown in Table 3-19. A total of 56.4% of the total group think the procedures are about right. The electro-mechanical group has 64.9% who felt the procedures are about right, the highest percentage for any group. In the electronic ratings, nearly equal numbers feel the procedures are too short or too long. When conducting personal interviews, it was noted that most interviewers thought of the MRCs and PMRMs when asked about periodic maintenance

procedures. Nearly all stated that they used PMS, not the manual, when performing preventive or periodic maintenance. Most are aware that MRCs are derived from the periodic maintenance information in the manual, but they also know that MRCs have been corrected and changed to eliminate mistakes and information gaps in the manual's procedures. Therefore, the majority have confidence in PMS, but not in the contractor's preventive maintenance procedures in in MOTD.

Compliments/Complaints – The interviews provided some insight into workers' opinions about MOTD periodic maintenance procedures and PMS. Some of these opinions are as follow:

Compliments about PMS and MOTD periodic maintenance:

- PMS is best for preventive maintenance
- MRC cards are good; phased maintenance is good
- PMS enhances reliability and maintainability
- MRC cards provide good step-by-step procedures
- MRC cards are easily carried to job sites
- MRC cards list all tools and materials needed
- PMS aid supervisor's maintenance work load planning
- SIMMS manuals have good preventive maintenance procedures

Complaints about PMS and Periodic Maintenance Procedures in MOTD

- MOTD procedures disagree with MRC cards
- Insufficient information is provided in the MOTD procedures
- Manuals cannot be taken to job sites
- Manuals are cumbersome for periodic maintenance use (as compared with MRC cards)
- MOTD procedures lack coverage of particular situations
- MOTD procedures are not useable in the equipment operating environment
- MOTD procedures are not "tailored" for the specific equipments or installations
- Excessive PMS is specified, requiring too many man-hours

Overall, the maintenance personnel like the PMS system. They believe it is the best way to perform preventive maintenance. The major dislike is the man-hours required for PMS. Work center supervisors state they do not have the manpower for the scheduled PMS time. Few respondents believe the periodic maintenance procedures in the MOTD would be adequate to maintain good operability and reliability for the equipment.

TABLE 19. RESPONSES INVOLVING PERIODIC MAINTENANCE

Response	Electronic Group	Electro-Mechanical Group	Mechanical Group	Total Survey
Too long	12.7%	4.5%	3.6%	7.5%
About right	52.0%	64.9%	57.5%	56.4%
Too short	12.1%	16.4%	24.7%	17.8%
No opinion	23.2%	14.2%	14.2%	18.3%

3.7 IMPACT OF THE SPARES SYSTEM ON MOTD USERS

Spare parts data presented in IPB format is very well received by maintainers who utilize the data for repair information and part numbers. The relationships between parts data in MOTD and the Navy Supply parts numbering system is poor because the parts numbering system is unwieldly.

When the questionnaire was being designed, the magnitude of the mutual impact between MOTD and spares was not anticipated. As a result, the area of spares was one in which the interviewers allowed the interviewees to discuss their responses at some length, even where the problem being stated was not strictly related to MOTD. The responses were quite strong, and predominately negative. The spares system is definitely a major problem from the maintainer's viewpoint.

The maintainer uses his spare parts when involved with corrective maintenance. This is normally a pressure producing situation during which time is important. The primary complaint, with respect to spare parts data, was that the part number given in the MOTD is not an adequate number for the supply system. When the maintainer has identified the part he needs to perform the repair, he begins the process of re-identification needed to obtain the like part from the supply system. This requires cross-reference to a Maintenance Parts List or Allowance Parts List to obtain a Federal or National Stock Number which is the number required by the supply system. Three problems arise from this scenario.

Problem One – The first is the excessive time absorbed in chasing parts. Part of this time expenditure is caused by the location of the work station with respect to the location of the parts data and supply. These areas are usually at two or three different locations. The other part of this time expenditure is spent locating numbers which are good (i.e., correct) FSNs or NSNs. On every ship surveyed, one or more men in each shop were engaged in full-time parts-chasing. Most interviewees estimated that 75% of that time was spent getting a "good number" and 25% getting the actual part. The men used in this parts-chasing role are quite often rated petty officers (e.g., 1st class electronic tech. 1st class mechanist mate, etc.). This means the Navy is using a large number of men, in which a significant training and experience investment has been made, as parts-chasers.

Problem Two – The second problem is the need to use MPLs and/or APLs as sources for cross-referencing the part number given in the MOTD into the correct FSN/NSN. Some interviewees reported that for some part numbers they had to search beyond the MPS/APLs into various other ship's data.

Problem Three – The third problem is the FSN/NSN and supply system itself. The numbers seem to change constantly, to the detriment of ships forces and to no one's benefit, at least from the viewpoint of the interviewees. Sometimes, one MOTD part number will cross-reference into multiple FSN/NSNs. The parts ordered are often wrong, necessitating a repeat of the cross-referencing sequence, all of which keeps the equipment being repaired out of operation.

Positive responses were given in two areas related to parts data. One was the favorable response to IPB coverage. The IPBs are used extensively for disassembly and reassembly in repair actions, and to positively identify parts. The responses indicated that part numbers could be more readily obtained, and that the confidence factor in the listed number is much higher. Many respondents, particularly in mechanical rates, stated the IPB to be the technical data

most used on the job. The second positive response was given to the use of microform, usually microfiche, in providing the parts cross-referencing data. Searching through a microfiche file for a part number appears to present little problem; however, a desire to have the microform reader and film located near the various work stations was expressed regularly.

In summary, the spares and spares data areas present significant problems to the maintainer-user. This is a good candidate area for improvement using existing techniques, such as IPBs and microform, with the potential for making large savings in costs and improving the effective use of trained maintainers.

SECTION 4
CONCLUSIONS

Section 4 – Conclusions
Subsection 4.1 – Impact of Media and Environment on MOTD

4.1.1 IMPACT OF ENVIRONMENT ON MOTD

Maintenance environments offer a variety of different working conditions and restrictions which affect the use of MOTD. MOTD features must match the work environment as well as user characteristics.

In the fleet survey two broad, interrelated areas were investigated: Physical characteristics of the technical manuals, and characteristics of the work environment. It is evident that there are environmental constraints imposed upon the maintenance technician/operator which influence the usability of the manuals. While these conditions vary (from flight deck line, to ship, to submarine, to shore-based facilities), there is nevertheless a requirement to consider these factors and weight them in the design of a technical data system. Since it is generally impractical to change the environment to accommodate the manuals, the effective resolution of these problems must be levied on the design of more suitably packaged technical information.

The problems associated with crowded work space impose practical considerations upon the packaging of MOTD. Whereas the lack of space for the manual (while in use) would not be entirely offset by reducing the size of TMs, this would still provide for easier handling of MOTD under crowded conditions. In effect, this is what the user is aiming for when he copies required information out of the TM, and takes only this information with him to the job.

A problem exists which presents similar requirements for excessively hot, cold, or hazardous work spaces. Under these circumstances, the MOTD user strives to complete his task and depart the work area as quickly and safely as possible. Often, work in these areas requires the constant attention of the user, and the situation does not lend itself to prolonged or extensive searches through the MOTD. Such data searches can be frustrating and distracting (e.g. it is difficult to turn pages while wearing gloves or heavy, protective clothing). The result can be that the technician will tend to avoid using the TM under such circumstances. Thus, adjustments in those TM characteristics which affect the ability to the user to expediently extract the required information should be carefully considered in the design of TMs for these users Such factors might include size, format, elimination of non-essential material, index tabs, and so on.

The problem of inadequate lighting could be critical under certain circumstances; for example, in a CIC during combat. Maintainers working in such areas often use a flashlight, with a red lens in order to read the manual. This can be highly inefficient, and increase the mean-time-to-repair for a given maintenance action. While this presents a difficult problem, a solution might be derived from engineering and human factors research into suitable alternatives to data presentation under conditions of low ambient lighting.

The portability of MOTD is an important consideration in many maintenance environments. For example, technicians often have to commute over physically awkward routes to get from the work center to the work site. Often, they will be required to transport all the required tools, test equipment, and consumable supplies in addition to the MOTD. These circumstances suggest the impracticality of employing MOTD in microform (thus requiring that some form of viewer also be carried along), and suggest that there are advantages to be derived from minimizing the physical size of any form of MOTD.

Many work spaces subject both the MOTD and the user to excessive dirt, oil and grease. This is particularly true for the maintainer who falls under one of the "mechanical" ratings (e.g. engineering and hull). Since the technician cannot be expected to clean his hands before turning a page, the manuals soon become greasy and dirty, and ultimately illegible. This results in a heavier requirement for replacement MOTD than is found in manuals used by other ratings. In order to alleviate this problem, the feasibility of producing TMs with treated or coated pages, which will resist dirt, grease and oil, needs to be investigated.

4.1.2 IMPACT OF MEDIA ON MOTD

Survey results show that formats and media used in MOTD for fleet and training use are not suited to user needs, preferences, application, and environmental constraints.

Survey findings disclose that definite user preferences exist for different types of MOTD and that a combination of media be used both in training and job applications. Various factors were found which would influence the type of data and media and their particular combinations; these include training, category of data types, job relevancy, portability of media, and frequency of use. Successfully bringing the proper combinations of these factors together for fleet and training use will provide an optimum match of the data, media and user environment to the users needs.

The survey revealed that, in seven data categories – equipment description, theory of operation, schematics/illustrations and preventive, troubleshooting, operation, and alignment procedures – the TM user expressed a decided preference for their presentation in printed books over any other medium. There was only marginal preference for other media (microfilm, audio-visual and CRT/keyboard) for some data categories. Preferences for the printed book for these data categories were based primarily on the user's experienced convenience, portability of media, frequency of use, and job application. Though many users had experience with these same data categories on other media, their major disadvantages matched the primary advantages of the printed book.

There were marginal inclinations to data categories presented on other media which are not to be discounted. Although many users expressed a stronger preference for the printed book in training applications, there was also an inclination shown by some users for mixed media. Many who preferred the printed book also saw the need for some types of data to be presented by another medium. The most prevalent types of data to be mentioned for job applications of microform were parts listings, illustrated parts breakdowns, ship technical documentation indexes, and those parts of a technical manual they use least.

A conclusion is that some data categories could be presented to the user on different media for training and fleet use. The data categories selected should be fully evaluated against a number of user considerations for these applications. These considerations should include training needs, user job tasks, frequency of use of data items, and environment. Althoughtthe user prefers the printed book to satisfy all these requirements, he may be amenable on other approaches given the proper approach. The major fault found during the survey with the majority of new media in fleet and training use was its improper introduction, and the lack of application of basic communication principles. Many of these principles embody user considerations, and are necessary for the success of any new medium or methodology.

In summary, the user wants the data and media matched to him, his training, job, and work environment. Although the user prefers the printed book in all situations and for all data categories, he would not be averse to utilizing proper application of any medium given a common sense approach. In the past, the choice of a medium has obviously not been based on any good analytic user-data match; rather, the choice of the medium has been insensitive to the nature of the users' need for extracting data from that medium. An example is the transformation of troubleshooting procedures from paper to microform which ignores the user need for simultaneous reference to more than one page, and to have legible data readily available at this work station.

4.2.1 MATCHING MOTD TO MECHANICAL RATINGS USER SKILLS AND JOB SITUATIONS

The mechanical ratings in the Engineering and Hull Occupation group need vastly improved MOTD support. Shipyard-produced MOTD needs strict management and quality control applied to the output. All MOTD for these ratings needs a more effective user-data matched format.

The mechanical rating personnel provide a unique MOTD user profile. The type of manuals they desire are similar to those produced as a matter of course in equivalent commercial applications. The militarization of this type of manual is an easy transition which could readily incorporate other desired changes as noted below.

The mechanical ratings need system-level coverage in the format mentioned above. The relatively large number of commercial manuals supplied to these ratings is a contributing factor to the lack of system level coverage. It is expected that commercial manuals are bounded by the physical limits of their equipment. To obtain the interface coverage needed, it is necessary to task an MOTD generation function with the system-level documentation. This will not occur unless given due specification and management attention.

Shipyard-designed equipment MOTD must be brought under the full attention of the SYSCOM's normal procurement cycle. Management of compliance with specifications and timely delivery of MOTD are required to cure the problems inherent in the present scheme. This strict management must also be applied to any change and update effort resulting from user feedback and equipment alteration programs.

The Ships Selected Records area, in total – not just technical manuals – must be brought into a managed system to correct the deficiencies found here. The specification needs changing so that Propulsion Operating Guides, Training Aid Booklets, and Engineering Operating Sequence System manuals are a requirement for all ships. This would best be managed by the SYSCOM's MOTD acquisition activity, and should include an update monitoring function to insure adequate compliance. A strict evaluation of SSR data is needed to determine what is needed, why it is needed, and how to get and maintain the resultant MOTD. Particular emphasis should be given the damage control documents which are critical when needed, and do not lend themselves to time-consuming considerations of ambiguous or misleading data.

The MOTD given to maintainers should consider their preferences and the environment surrounding the equipment. This data should be pictorial, address physical dimensions and tolerances, and be produced in a size and of a medium which is readily usable in dimly lit, cramped, oily quarters.

In summary, the techniques, format, and style required to improve the MOTD are presently available. It is thus a matter of applying good management techniques to the problem after it has been adequately defined. The problem/definition approach is needed (i.e., not one which considers SSRs to be in one area of responsibility and MOTD in another). The problem definition should then be the basis for evaluating solutions from the point of view. The solution will be a management of MOTD acquisition from the MOTD generation activities which serve the user.

4.2.2 MATCHING MOTD TO ELECTRONIC AND ELECTRO-MECHANICAL RATINGS USER SKILLS AND JOB SITUATION

The electronic and electro-mechanical ratings have MOTD problems with spares, level of coverage and troubleshooting procedures. The MOTD problems are often masked by these ratings because they "find a way" to do the job.

The electronic and electro-mechanical ratings have MOTD problems somewhat different from the mechanical ratings. These ratings are usually given MOTD that is produced by contractors, and is subject to a procurement/buy off cycle which is specified and controlled by a SYSCOM. The results are spotty, but can be resolved by improved management.

Frustration to many maintainers occurs when their MOTD is constrained to coverage which stops where the maintenance philosophy specifies replacement, when in fact the spares to support that philosophy are not available. The maintainer, caught in this dilemma with a broken equipment/system which is critical to ships' performance of mission, finds himself under extreme pressure to repair the equipment/system. If the MOTD were not constrained, he may well be able to make the necessary repairs.

Troubleshooting procedures were reported to be unsatisfactory by many maintainers. (See Topic 3.3.4.) The most common complaint was that the procedures did not isolate the faults which occurred during normal operation. The problem appears to be that the procedures are developed on a convenience basis; the MOTD generation group covers those faults which they can conveniently work out, or the faults derived by maintainability/reliability studies, and not based on faults which are actually occurring in the field.

A second problem is that fault isolation procedures were not straightforward and logically derived. It should be recognized that the maintainer performs logical, deductive reasoning to isolate and repair faults. The MOTD must use the same technique, or its value is diminished. Equipment design, by its very nature, lends itself to deductive isolation of malfunctions and this logic can be proceduralized if given sufficient evaluation and testing.

The format desired by these ratings has to do with their normal operating methods. Electronics is best portrayed by schematic or functional block diagram coverage. These individuals are trained in use of these formats, and are comfortable if given good, diagramatic coverage. In difficult situations, they will refer to theory data using the diagrams in conjunction with the text. This creates the need for media which allow looking at two things at once, and makes the graphic techniques of the diagrams very important. The use of color was often mentioned as desirable and effective. The SIMM and FOMM use of two-color/two-shade illustrations proves very popular and effective to these users. One of the best coverages seen was in DATOMS, as produced by General Electric for the AN/SQS-53 Sonar equipment. This uses color-coded schematics in a particularly effective manner. While this reflects added acquisition costs, it is felt that the effectiveness in coverage would compensate for this cost in producing a higher rate of equipment/ system readiness.

Operations coverage, particularly system-level, is needed. There is often not enough to enable a maintainer to isolate the major equipment item which has malfunctioned. Augmented system-level coverage would provide the data needed to permit rapid fault area isolation and save considerable repair time (equipment/system downtime). Operations personnel currently have to generate their own procedures based on the data in maintainer-oriented books. This results in procedural inconsistency among various ships and reduces the effectiveness of newly transferred personnel. Operations data is particularly

deficient where the equipment being operated is computer-controlled. Good computer-user coverage is needed to make full use of the capabilities of the man as well as the machine.

4.3.1 MOTD USER NEEDS AND PREFERENCES

Findings concerning "MOTD User Needs and Preferences," reveal that the bulk of the problems in this area can be subsumed under the general headings of Quality Control (including standardization) and Comprehension. It is felt that these factors impact both the training and the maintenance environments and are prime sources of user concern.

The findings concerning MOTD accuracy disclose numerous deficiencies in existing manuals which will not be rectified by revising or improving the presentation techniques. Technicians and instructors alike have indicated that the data is inaccurate (even in new TMs), incomplete (or at the very least inconsistent in level-of-coverage), out-dated (particularly from the standpoint of the timely incorporation of modifications/revisions), or missing entirely. Though these problems are deemed most severe in manuals associated with shipyard designed and installed equipment, respondents asserted that virtually all categories of technical manuals are similarly deficient. In particular, these deficiencies are most strongly perceived in the Procedures, Theory, and Description sections of the technical manuals. It is important to note here that the Procedures and Theory sections were designated as the first and second most used sections, respectively, of the technical manuals (see Topic 3.3.3). The possibility that the technicians perceive more errors in these sections only because they are used more often is not an important consideration. What is important is that these deficiencies do exist, and are viewed by the users as greatly impairing their ability to do a job.

These circumstances precipitate further problems in the areas of training and maintenance. Instructors view the technical manuals as being highly ineffectual for training purposes. The application of these manuals often necessitates the rewriting of substantial portions by the instructors, as well as the generation of large amounts of supplemental material. It is a moot point, then, as to whether the manuals are presently of any substantial value within the context of training. Even on the presumption that they may provide for some measure of data transfer from the training environment to the operational setting, the matter of the inadequacy of the data greatly diminishes their value. Moreover, many respondents stated that they tend to avoid using the manual because they do not believe, based upon experience, that it will help them to any appreciable degree, and that it might confuse them. The experience of these individuals has often been that the data in the manuals is not only inaccurate or incomplete, but that these deficiencies are often discovered during the course of performing some maintenance activity. There is perhaps a certain element of irony in the fact that, the quality of the manuals notwithstanding, they are still the preferred medium for presentation of the information. As can be seen in Table 4-1, the printed book is the medium of choice for all sections of the manual, as well as for the associated drawings and illustrations. It would appear, then, that what is of primary concern to the user is not necessarily the form in which the data is presented (although there are some problems here), but rather the substance of the data itself.

Related to the above, in terms of overall quality and utility, are the problems discussed in Topic 3.3.4 concerning Illustration Techniques. In this area, the survey sample expressed a strong preference for more complete representation of technical data in graphic form. In particular, they indicated that such illustrations are extremely useful, and there are just not enough illustrations to adequately illustrate the maintenance activities covered by the manuals.

TABLE 4-1. RESPONSES INVOLVING PREFERENCES

Question	Response	% Responding
Preferred media for Description Section is...	Printed Book	58.0
	Microfilm with Viewer/Printer	15.6
	Audio-Visual Tape with Viewer	9.3
	CRT with Keyboard for Questions	3.2
	Other	0.0
	No Opinion	13.5
Preferred media for Theory Section is...	Printed Book	54.5
	Microfilm with Viewer/Printer	11.2
	Audio-visual Tape with Viewer	12.6
	CRT with Keyboard for Questions	7.4
	Other	0.7
	No Opinion	13.3
Preferred media for Operating Procedures is...	Printed Book	64.1
	Microfilm with Viewer/Printer	8.1
	Audio-Visual tape with Viewer	7.0
	CRT with Keyboard for Questions	5.1
	Other	1.4
	No Opinion	14.0
Preferred media for PM Procedures is...	Printed Book	65.3
	Microfilm with Viewer/Printer	10.3
	Audio-Visual Tape with Viewer	1.8
	CRT with Keyboard for Questions	3.9
	Other	4.4
	No Opinion	14.0
Preferred media for Troubleshooting Procedures is...	Printed Book	60.8
	Microfilm with Viewer/Printer	10.0
	Audio-Visual Tape with Viewer	3.0
	CRT with Keyboard for Question	10.5
	Other	0.9
	No Opinion	14.5
Preferred media for Alignment Procedures is...	Printed Book	63.4
	Microfilm with Viewer/Printer	10.0
	Audio-Visual Tape with Viewer	5.3
	CRT with Keyboard for Questions	5.6
	Other	0.4
	No Opinion	14.9
Preferred media for Schematics/Diagrams is...	Printed Book	67.2
	Microfilm with Viewer/Printer	13.1
	Audio-Visual tape with Viewer	2.3
	CRT with Keyboard for Questions	2.8
	Other	0.9
	No Opinion	13.5

4.3.1 MOTD USER NEEDS AND PREFERENCES (Continued)

What is perhaps more important is the survey data concerning the present quality of technical manual illustrations. The implication derived from the responses is that merely increasing the volume of graphics will not necessarily effect any wide-reaching improvements as far as the user is concerned. Any increase in the ratio of illustrations to text must be accompanied by improvement in the quality of these illustrations. Factors which consistently drew criticism include clarity and contrast in photography, size and clarity of printing, and the widespread practice of reducing the size of illustrations to the point where they are illegible.

These factors, as well as those relating to MOTD accuracy, fall largely within the purview of quality control and, by virtue of MOTD application, affect both training and maintenance. What is indicated here is the general requirement to invoke more stringent, thorough, and realistic criteria in the determination of both the content and quality of the technical manuals. This requirement should precede any meaningful consideration of alternatives concerning mode of presentation.

One additional finding related to illustration techniques should be discussed here – the variation of preferences for types of illustrations expressed by individuals representing different job classifications. As mentioned in Topic 3.3.5, this finding would support the contention that careful consideration should be given to the type of job, or ultimate application, for which illustrative material is being developed. In addition, it is important to insure the standardization of these illustrations from manual to manual. Numerous individuals surveyed expressed concern here, and contend that such standardization would do much to alleviate the confusion inherent in using the manuals.

Topic 3.3.2 pointed out that the manuals are failing to communicate effectively with approximately 20% of the users, who feel that either the technical level of the writing is too difficult, or that the writing is neither clear nor logical but rather confusing. It should also be pointed out that, as has been noted by Powers[4], "Readability ... refers not merely to the printed narrative of technical manuals, but more importantly, to graphics/words combinations." This problem, then, is intimately related to the problems concerning illustration techniques, and it is therefore reasonable to expect that an effective resolution of either text or illustrations problems will necessarily involve appropriate consideration of the other.

It may be helpful to consider together the problems concerning Standardization (Topic 3.3.2) and the findings regarding the Most and Least-Used Sections of the Manual (Topic 3.3.3). A sizable number of those interviewed indicated that various factors subsumed under the heading of standardization contribute to the confusion and inherent difficulty in using the technical manuals. Among the factors mentioned are non-standard format, illustration techniques and terminology. The area of illustration technique has already been discussed. Standardization of terminology would do much to increase the comprehension of the material, especially among individuals with a lower reading ability. Confusion and lack of comprehension was evident among users who made comments

4. Powers, Thomas E., Navy Enlisted Personnel Characteristics, Man Tech Corporation of New Jersey, June 1976, pp. iii, 2-3.

such as "Why don't they call things what they are, instead of using engineering jargon?" Such problems are apparently more acute when an individual is faced with using technical manuals developed by different sources.

Perhaps the most frequent format complaint encountered by the survey team concerned the lack of a standard organization of data, and in particular of sections within a manual. Individuals expressed the desirability of always having each section located in the same sequence, and having the same relative content, in all manuals. This type of standardization should certainly facilitate the process of information retrievel. However, it also raises another possibility when considered in light of the findings concerning the most and least-used sections of the manual.

It was mentioned in Topic 3.3.3 that not all data is required by everyone, all of the time. Further, interviewees expressed concern about having to wade through vast amounts of data, which are neither necessary nor helpful, in order to locate information which is required. One way to alleviate this situation might be to consolidate portions of certain sections, or even entire sections in some cases, into reference volumes which need not be carried around by the technician in performing the majority of maintenance tasks. Optimization in this area might well lead to substantial benefits such as:

1. Increased economy in production, replacement, and updating of technical manuals,
2. Easier handling (due to less bulk), resulting in concomitant savings in time and effort on the part of the technician, and
3. Reduction in Mean-Time-To-Repair.

While it is by no means suggested that the above would be a panacea in establishing a user-data match, it is suggested that such an approach might do well to be considered as an element of a viable technical data presentation system. Non-essential data, whether randomly distributed throughout the technical manual or inserted in bulk, impedes the technician in the process of information retrieval, making it both awkward and time-consuming. To optimize maintenance, technical manuals should include only information which is necessary to satisfy the user-data interface requirements.

Finally, it should be emphasized that all of the considerations mentioned above are by no means peculiar to the job environment; there are implications here for training as well. In particular, it is often desirable to develop manuals which have a dual application: training and maintenance. In this regard, it can be said that the problems discussed above can have an even greater impact on the utility of a given document in the training environment as opposed to the job setting. The technician employing the manual in the performance of his maintenance job has the advantage of previous training to assist with the use of the manual. Knowledge gained during training, together with that acquired on-the-job can be applied to the interpretation of ambiguous data, and may supplement or rectify missing or erroneous data. This capability, if it exists at all for the trainee, is severely limited and therefore underscores the need for optimizing all data presented in the technical manual.

4.4.1 USE OF MOTD IN FORMAL AND INFORMAL TRAINING

In addition to problems concerning accuracy, comprehensiveness, and understandability of MOTD, problems also appear in matching the contents of training and of MOTD with the users' job performance requirements.

Given the findings concerning the use of MOTD in training (Topic 3.4) one question which emerges is "How do the structure and content of the manuals impact the training community?" Considering both structure and content, a formidable problem is seen with the ability of the users to comprehend what the manual is trying to say. This is perhaps the most significant finding concerning the impact of MOTD on training. Assuming that the manual is an appropriate medium for presenting the material, and that its emphasis as a training aid is fundamentally sound, the next most important consideration from the standpoint of instructional technology is "Does the medium effectively communicate with the student?" It is here, as we have seen (Topic 3.3.2), that approximately 20% of the user sample has expressed difficulty.

It has also been pointed out that, in the main, technical manuals are not being used by instructors as training aids without substantial "rewriting" and supplementing of the information within them. This means that an instructor is forced to expend preparation time (which could be more efficiently put to other uses) on alleviating a problem which should not fall within his purview. Even if this function were to fall within the domain of the instructor, the ultimate wisdom of this delegation of responsibility is somewhat specious when viewing the survey data concerning the perceived accuracy of the information contained in the manuals. The disparity of opinion between the instructors and the "users" suggests that the instructor may not, in some instances, be as aware of the inaccuracies in the MOTD as one might prefer.

Aside from the issues of accuracy and understandibility, the issue of topic coverage emerges as an area of concern for training. If the reports of those interviewed are fairly representative, there is an indication that rather than providing uniform coverage of the various sections of the manual, more emphasis during training might be placed upon the use of Procedure and Theory sections, and concurrently upon the use of the accompanying diagrams and illustrations. It is these areas which, according to the survey sample, are used the most in the actual job environment. Further, the use of the "Troubleshooting" portion of the Procedures Section was identified as a particular area of concern to the survey respondents. Table 4-2 presents three of the survey questions which dealt with troubleshooting. As seen, the instructors tend to indicate that the coverage afforded this topic is "about right," while the users feel that it is "too short." The user would like to see a step-by-step representation of these procedures combined with explanations of why each step is performed.

It may be argued that Troubleshooting is a difficult topic to address with any degree of absolute comprehensiveness. After all, troubleshooting techniques are largely heuristic in nature, and the procedures serve primarily to guide the technician in the proper direction for problem resolution. Be that as it may, there is at the very least an indication that the use of the manual and the application of the troubleshooting procedures require a more comprehensive treatment during training. Since the manuals are not presently used in training on an "as-is" basis, it is currently a moot point as to whether the difficulty resides primarily within the manual or the training in this area.

A requirement for providing technical manuals to trainees on a permanent-issue basis is not clearly established. Only about half of those responding

expressed positive feelings in this area and, in point of fact, there were more feelings expressed concerning the inherent disadvantages in individually owning technical manuals than for advantages. In fact, in view of the stated feeling that it would be bothersome to be required to maintain a set of manuals, there is some basis for opting for the centralized location of technical manuals which would be updated by some individual(s) specifically delegated that responsibility.

There is the general feeling among MOTD users that while a multimedia approach has a place in the formal training environment there should be careful consideration of the disadvantages of expanding the application to the OJT and maintenance environments. In particular, there is concern over the problems involved in carrying viewers or recorders up and down ladders, and setting up the equipment in quarters which are cramped and otherwise ill-suited to the purpose. In addition, there is the concern over the reliability of any such equipment. The users are ambivalent due to the prospect of being hampered by malfunctioning equipment. Finally, there was a hint of "resistance to change" among the users. This was evident in some statements which alluded to the superiority of the printed technical manual over other media because "it is easier to find what I am looking for" in the manual.

What may be called for here is to formulate an overall Instructional System Development (ISD) approach which takes into account all of the training elements – instructor, student, MOTD, and training aids. The design, approach, and content of technical manuals can then be revised in the light of recommendations derived from the ISD approach, to make the manuals more amenable to direct application in training. This is an issue which does not fall within the scope of the present survey, but which warrants thorough investigation.

TABLE 4-2. SURVEY RESULTS INVOLVING TRAINING CONSIDERATION

Question	Response	Instructors (%)	Technicians (%)	Operators (%)	Composite (%)
Are the troubleshooting procedures... ?	Too Long	18.9	6.2	8.1	7.7
	About Right	50.0	34.2	30.6	35.3
	Too Short	27.5	51.4	55.1	44.2
	No Response	3.4	8.0	6.1	12.6
What kind of troubleshooting procedures would you like to use?	Step-by-Step Instructions	55.1	49.1	46.9	45.6
	Tables with pictures and explanations	3.4	16.0	16.3	13.8
	Flow Charts	34.4	24.5	32.6	25.7
	Other	1.7	0.5	0.0	0.7
	No Response	5.1	9.7	4.0	14.0
Should the procedures explain why each step is done?	Yes	62.0	69.7	71.4	64.6
	No	36.2	24.0	26.5	25.0
	No Response	1.7	6.2	2.0	10.3
Total Individuals Responding		58	175	49	427

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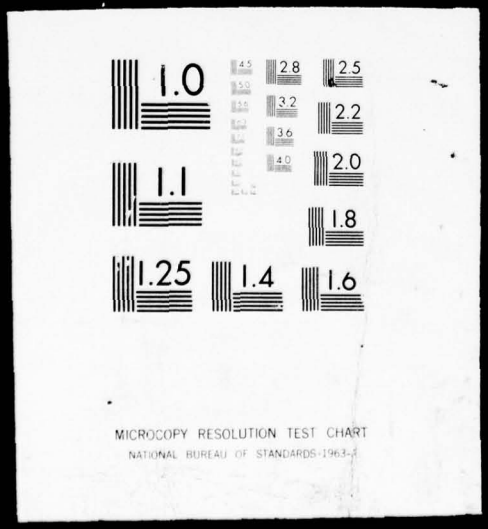

4.5.1 IMPACT OF MOTD CHANGES AND CORRECTIONS ON THE USER

Current performance of MOTD update operations, and of the user-generated correction feedback system, are adversely affecting MOTD users. Improvement is needed in both areas.

Findings of the survey indicate that the MOTD update performance for shipyard designed and installed equipment is poor. The original data generated by shipyards does not appear to be controlled by specification or managed by an outside agency (i. e. , another government agency). The effects of this poor update performance on the MOTD user are to reduce his confidence level in the MOTD, reduce his performance on the job, and change the learning technique for the equipment/system to a strictly OJT (show-and-tell) transfer of knowledge. This reduces equipment/system readiness and makes the retention of experienced personnel, at a particular duty station, critical to the operation of the ship.

The lack of response from the feedback system makes the main thrust of the system ineffectual. The feedback system simply does not communicate. The procedures and forms are viewed by the MOTD user as one more unpleasant task to a maintainer who already has too many forms to fill out. Any reporting of this type which does not provide a prompt reply to the originator is not providing the feedback component of communications, without which there is no real communication. The only occasions wherein feedback occurs are when a change is sent. This does not provide the personal reinforcement needed to make this system effective. The timespan between input of a comment and the visible output is too long to support further use of the system for most respondents.

Another factor which interrelates the subjects of update and feedback occurs when MOTD is produced *in preliminary* form, and years pass before final data is produced. (This occurs in aircraft electronics, avionics, and shipboard electronics systems more than with the electro-mechanical and mechanical equipment, although this may be attributed to the fact that most of the latter equipment is supplied with commercial manuals.) This long-term use of preliminary MOTD is viewed as poor performance by the manufacturer involved and by the responsible SYSCOM, and forces the user into a strong reliance on his own skills, training materials and tech-rep help. The user is also reluctant to write up Unsatisfactory Reports for preliminary MOTD, since he tends to assume that the final MOTD is in progress and may correct any errors he might report now.

A conclusion drawn here is that more consideration must be given to the users' needs, and the MOTD generation and acquisition activites be put on better managed, more stringent schedules of performance. Further, the feedback system must be made responsive to the user. The MOTD generation and buyoff activities, and the many groups who accumulate related paperwork, must reorient this system to place more emphasis on supporting the user and his MOTD.

4.6.1 MOTD USE IN PREVENTIVE MAINTENANCE SYSTEMS

Two preventive maintenance systems were assessed in the survey – the Planned Maintenance System (PMS) and the preventive maintenance requirements originated by the contractor. The latter are included in MOTD, and are often referred to as periodic maintenance requirements. Strong user preferences for PMS are based on recency, portability, completeness, and tailoring to user needs.

Early in the survey it became apparent that preventive maintenance information existed in two categories. When "preventive maintenance" was mentioned to maintainers or operators, they thought of the PMS. When clarified to mean "preventive maintenance contained in technical manuals," they replied, "Oh, you mean 'periodic maintenance' or contractor's preventive maintenance requirements'." Not anticipating this, the survey questionnaire inquiry involving preventive maintenance (how would you rather perform procedures such as alignment, checkout, and preventive maintenance;) offered a choice of three responses, but PMS was not one of them. Nonetheless, PMS (MRC's) was frequently given as the answer. When interviewees selected the "abbreviated checklist" option as their answer, they were asked as a follow-up question: Do you use anything of this type in your job now? Many times the answer was again PMS or MRC's. Further questioning determined that maintenance personnel consider the PMS MRC cards as abbreviated checklists comprised of step-by-step procedures. To a related question (Are the periodic maintenance procedures too long, about right, or too short?) many interviewees once more cited PMS as the answer. Some asked what was meant by periodic maintenance procedures. When it was explained that this referred to the contractor's preventive maintenance procedures in technical manuals, the frequent response was, "Oh, we don't use those anymore; we use PMS." Another answer was, "They are not any good; PMS has replaced them." As a result, the answers given during the interview were annotated as to whether the response was related to the PMS MRC cards or not.

Analysis of responses involving preventive maintenance is given below divided by periodic and preventive categories.

Periodic Maintenance Analysis – Preventive Maintenance (PM) procedures given in MOTD are rarely used. The principal reason is because it has been superseded by the PMS. The MOTD is normally used as the basis for developing procedures for MRC cards, after which the MRC card's procedures are corrected and validated by Navy personnel before fleet use.

PM procedures are not tailored for the individual equipments and ship. For example, PM procedures may be available for Pump type A, but modifications have now placed Pump type B on board. Maintenance personnel indicate that they would be unable to maintain equipments in reliable operational status if they had to use the manual's PM procedures.

PM procedures, as written, do not consider the environment in which equipments operate. Preventive maintenance requirements for an equipment designed to operate in an ambient temperature of 85° may not be sufficient for temperatures of 110° or 140°. Operating environment was not considered, and the period for suggested PM by the contractor is not always adaptable to the operational utilization of that equipment.

PM procedures are not easily used at the job sites. The MOTD man-data interface does not consider the work area. Environmental factors such as light, noise, heat, greasy/dirty work areas, flight deck/line areas, cramped spaces, etc. are all related to use of the manual at the job site. Workers state,

"I cannot use a manual on the flight line/deck, or when I am standing on my head behind the equipment trying to do my job." Portability of the data is a primary consideration.

PM procedures are not written in a good step-by-step format useful to the maintainer. Maintenance personnel consider the procedures confusing. Most procedures cover several types of PM requirements grouped together and written as one lengthy procedure. Workers like procedures sectionalized into specific PM types with a step-by-step procedure for each type.

PMS Preventive Maintenance Analysis – PMS appears to be the best currently available method for doing preventive maintenance. This was a frequent statement by maintenance personnel. PMS is useful for maintenance managers and maintainers because it provides more preventive maintenance than the minimum requirements listed in technical manuals. Manpower shortages cause problems for the PMS manhour requirements, but this is not necessarily a fault of PMS. PMS addresses the man-data needs, and is a valuable asset for training purposes, especially for OJT and PQS training.

Maintenance Requirement Cards are useful tools for the maintainer. The MRC card describes the job procedure in a simple, explicit, step-by-step method, with information about tools, parts, materials, and test equipment. Safety precautions are defined; system, subsystem, and component identification is listed. The maintainers like the size and portability of MRC cards for use in work areas where a manual could not be used.

Aviation maintenance personnel like the phased maintenance method of PMS. The Periodic Maintenance Requirements Manuals (PMRMs) and other preventive maintenance publications are used to plan and control scheduled maintenance actions. The step-by-step procedures for performing inspections and maintenance are useful and liked by the maintainers. The phasing of maintenance actions, considering commonalities and similarities of all tasks, allows more work to be done in less time.

Initial data needed for the development of MRC cards is obtained from the manufacturer's technical manual for that equipment. The MRC card can be corrected and updated by the users via the PMS discrepancy reporting and feedback system. However, for new equipment, the MRC cards will be better if the contractor does a good job. When the card is valid for the equipment it supports it is then more useful than the procedures in the manuals. Manuals are rarely corrected or changed to include this data.

4.7.1 IMPACT OF THE SPARES SYSTEM ON MOTD USERS

The current spares system needs improvements to make effective use of manpower and to improve equipment/system readiness. An all-encompassing cost effectiveness evaluation is needed.

The existing system for spares support is not working effectively. Part numbers alone are causing serious problems in the use of trained manpower and equipment/system readiness. The entire system should be investigated with the objective of making it responsive and simple in operation.

It is possible to reduce the impact of this problem on the fleet user. This can best be accomplished by providing IPB coverage for equipment/systems with rigidly controlled use of FSN/NSN parts numbers. The trained technician should be freed for maintenance activities by reducing his part number search time to an absolute minimum. This will be accomplished if the IPB with FSN/NSN is a part of, or co-located with, his normal maintenance MOTD. The use of microform would offset this slightly, in that the microform file and reader are not normally located where the maintenance action occurs; however, the effective coverage would make this a minor problem in most cases.

The current system appears, from the user viewpoint, to be a blizzard of paperwork and bureaucracy which serves itself and not the user. The forms are hard to fill in because they were designed to be key-punchable without any conversion. The result is that the maintainer's time is spent in coding forms to support a spares data base, rather than performing the job for which he was trained.

SECTION 5
RECOMMENDATIONS

5.1 RECOMMENDATIONS OF THE FLEET SURVEY TEAM AND NTIPP STAFF

The recommendations derived from the fleet survey reflect the careful consideration of the limitations of survey techniques in general, as well as the constraints imposed by practicality and utility within a technical manual system context.

As preliminary recommendations were generated, it was recognized that they could be logically grouped into four areas of application. These areas are: technical manual system management, the technical manual acquisition process, content generation, and training. Since the correspondence of the recommendations to the four areas was so readily apparent, it was decided to consult other NTIPP staff regarding the validity and practicability of these recommendations. The resulting list of recommendations thus reflects the combined efforts of the fleet survey team, as well as of those members of the NTIPP staff who have primary responsibility for research in the areas of management, acquisition, content generation, and training.

Management – Recommendations in this area can be subsumed under two general categories: feedback and update.

With respect to feedback, the specific recommendations are as follow:

1. Response to the feedback report should be routed directly to its initiator (i.e. the MOTD user) within fourteen days of receipt.
2. The feedback report should consist of a single form which is easily filled-out.
3. Feedback reports for MOTD should be routed directly to the responsible activity.
4. Valid comments received against any MOTD should be distributed within fourteen days (by bulletin) to all users of that MOTD.
5. Feedback reports concerned with preliminary MOTD should be encouraged and responded to within fourteen days.

A management activity which addresses the entire MOTD set represented in the Ship Selected Records should be established and maintained. Particular attention should be paid to the MOTD generation and update functions performed by shipyards. Particular recommendations concerning this management function include the following:

1. Establish a standard, complete procurement cycle for MOTD which supports shipyard designed equipment.
2. Establish a separate organization whereby the shipyard MOTD produces interface with the responsible (SYSCOM) on a contractor-to-customer basis.
3. Evaluate the impact on the entire system of all changes, updates and alterations. Insure that updates are complete packages.
4. Increase ship inspection survey (INSURV) and OPEVAL teams, with MOTD and SSR inspectors to verify or obtain ship's force inputs to update efforts.
5. Provide specified update/change efforts to reflect any change in FSN/NSN part numbers.
6. Updated MOTD should be delivered concurrently with completion of any SHIPALT or field change.
7. Update should be made a scheduled warranty item for two years after initial system/equipment delivery.

TM Acquisition – In the area of TM acquisition, the recommendations address two interrelated areas: the user-data matching process and the

generation of specifications for technical manuals. Specifically, these recommendations are as follow:

1. Specifications must ensure that data and media are matched to the user – his/her training, job, and work environment.
   - Provide MOTD which can be used effectively in cramped, crowded, and hazardous work spaces and those having unusual working conditions or problems.
   - Provide MOTD which is usable in low-light level and dark work space/areas where applicable.
   - Provide MOTD which has printed pages that are grease and grime resistant.
   - Provide MOTD manuals which have transportability features and are easily positioned for user referencing at job site.
   - Limit theory to that needed for understanding of functions (e.g., little need for equations, physics, etc.).
   - Integrate illustrations with step-by-step procedure.
   - Provide dimensions and tolerances in both accessible, tabular form, and in proper procedural steps.
   - Use effective indexing, both cross-reference and subject, and sectionalize on logical basis (i.e., by functional unit).
   - Specifications should be developed which mandate the type and quality of illustrations used for each type of technical manual, depending specifically upon the rating of the individuals who will be using the technical manual. The user should not be plagued with illustrations which are too blurred or too small to be easily read, nor with photographs which are blurred, too dark, or have poor contrast.
   - PM procedures in the MOTD are not user/job related, nor tailored for the specific system or ship. TM specifications must ensure that the optimal man-data interface is achieved. Data content, retrieval and presentation methods and transportability must be matched to the user and his work environment. It must also be tailored, for the specific system or ship. PM procedures may be identical for a specific system, but differences in equipment operations, installations and worker's environment require tailoring of the procedure to cover the variances. This should be included in the responsibilities of the content generation and integration functions.
   - The level and style of writing used in technical manuals should be carefully examined and adjusted downward to accommodate individuals having lower reading abilities. The Army is leaning toward the fifth grade reading level in the development of much of its training materials and technical documentation.
2. Specify troubleshooting procedures which are verified and subject to warranty correction for initial use of production system (e.g., 18 months, 2 years, etc.).
3. Provide for in-fleet followup of use and effectiveness of troubleshooting procedures during warranty period.
4. Specifications should require all spare parts to be listed both in the original manufacturers part number and the FSN/NSN.

5.1 RECOMMENDATIONS OF THE FLEET SURVEY TEAM AND NTIPP STAFF (Continued)

5. Shipyard-produced MOTD should be treated identically to that of contractors with respect to meeting specifications, being reviewed in-process, monitoring of validation/verification, and delivering on time.
6. All MOTD should be delivered concurrently with equipment.
7. Preliminary MOTD should be made final within one year of initial delivery.
8. The findings concerning MOTD adequacy, in terms of accuracy, completeness, and standardization, indicate the requirements for developing specifications and methods of implementation for MOTD quality control. In developing specifications, particular attention should be paid to verification of maintenance procedures and data. Verification should be performed at Naval installations, and by Navy personnel. SYSCOM and contractor/shipyard personnel should participate in the verification process as observers. The process of verification should thoroughly and completely cover every operation, maintenance, and troubleshooting procedure contained in the technical manual. Validation of technical data should continue to be performed by contractor/shipyard technical personnel, under government supervision when appropriate.
9. Concerning the standardization of MOTD, it is recommended that specifications for development of all future MOTD provide for consistent organization, presentation techniques, and terminology. Each numbered section in a particular type technical manual should contain the same type of information (i.e., Description, Theory, Operating Procedures, etc.).
10. Terminology should be consistent from manual to manual, as well as within each technical manual. In all cases where technical or engineering terminology apply, these terms should be listed in a glossary appended to the technical manual for ready access and use.
11. The feasibility of extracting large portions of data from the technical manual and consolidating this data into separate reference volumes should be investigated. Data not essential to the procedures involved in maintenance should be considered for extraction and consolidation, making the technical manuals easier to use due to reduced bulk and greater ease in locating information. This might entail an approach to technical manual development similar to that which is currently being taken by the U.S. Army in its Improved Technical Documentation and Training (ITDT) programs.
12. The development of specifications for (and final acceptance of) technical manuals should be subject to participation by knowledgeable representatives of both the maintenance and training communities. This would help to insure that technical manuals will be put to maximum use in both areas.

Content Generation – Only one recommendation was derived which pertains to the area of content generation. However, the importance of this recommendation cannot be overstated. This is the contention that basic writing and communication skills/principles should be employed, on a full-scale basis, to the development of technical manual content. The writers should be carefully selected, and their skills upgraded through supplemental training where required. In addition, this recommendation would dictate an editorial approach to technical

manual development which would help to insure the effective communication of information to the user.

Training – While training was not the primary focal point of this survey, there were some recommendations derived from the study which do pertain to the training/technical manual relationship. These recommendations are as follow:

1. MOTD should employ a multi-media approach to satisfy multiple training applications/requirements. The proliferation of a multi-media approach to the distribution and use of MOTD must be undertaken with special attention to factors involving the reliability and portability constraints imposed by the operational setting. Even so, it is to be expected that there will be a certain amount of resistance on the part of the user.
2. The application of technical manuals to the formal training environment underscores the requirement for making adjustments to the technical level and writing style of the manuals. In particular, the manuals should be developed so that they can adequately communicate to prospective users having a lower level of reading ability.
3. The development of the content of the various sections of the technical manual should reflect the differing requirements for use in the operational setting. Those sections which are more frequently required for use should be given additional attention during their development, and should provide a more thorough and comprehensive treatment of the subject matter than would be required of sections which are comparatively seldom-used.
4. Technical manuals should be developed through a procedure which includes a more active participation by the Naval training community. Further, the design, approach, and content of these manuals should be based upon recommendations derived from an Instructional System Development (ISD) approach. The objective here should be to produce technical manuals which are readily amenable to application in the training environment and which are concurrently responsive to the requirements of the operator and maintenance communities.

APPENDIX A
REFERENCES

Appendix A.

REFERENCES

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APPENDIX B
GLOSSARY

Appendix B

GLOSSARY

Abbreviation or Acronym	Full Terminology
AEL	Allowable Equipment List
AL	Allowance List
APL	Allowance Parts List
ATE	Automatic Test Equipment
CIC	Combat Information Center
COSAL	Coordinated Ships Allowance List
CPO	Chief Petty Officer
CRT	Cathode Ray Tube
D	Depot (as in maintenance levels)
DATOM	Data Aids for Training, Operations, and Maintenance
DID	Data Item Description
DTNSRDC	David W. Taylor Naval Ship Research & Development Center
EOCC	Engineering Operational Casualty Control
EOP	Engineering Operations Procedure
EOSS	Engineering Operation Sequence System
FOMM	Functionally Oriented Maintenance Manual
FSN	Federal Stock Number
GIB	General Information Book
HAC	Hughes Aircraft Company
I	Intermediate (as in maintenance levels)
INSURV	Inspection-Survey
IPB	Illustrated Parts Breakdown
ISD	Instructional System Development
LCC	Life Cycle Cost(s)

Abbreviation or Acronym	Full Terminology
MCAS	Marine Corps Air Station
MDC	Maintenance Dependency Chart
MIARS	Maintenance Information Automated Retrieval System
MMM (or 3M)	Maintenance, Material, and Management (System)
MOTD	Maintenance and Operation Technical Data
MOTU	Mobile Technical Unit
MPL	Maintenance Parts List
MRC	Maintenance Requirement Card
MTBF	Mean-Time-Between-Failure
MTTR	Mean-Time-To-Repair
NAMTRADET	Naval Air Maintenance and Training Detachment
NAS	Naval Air Station
NATSF	Naval Air Technical Service Facility
NSN	National Stock Number
NTIPP	Navy Technical Information Presentation Program
O	Organizational (as in maintenance levels)
O/I	Organizational/Intermediate (maintenance level)
OJT	On-the-Job Training
OPEVAL	Operational Evaluation
PEB	Propulsion *Examining Board*
PERA-CV	Planning, Engineering, Repair, and Alteration for Aircraft Carriers
PM	Preventive Maintenance
PMRM	Periodic Maintenance Requirements Manual
PMS	Planned Maintenance System
POG	Propulsion Operating Guide
PQS	Personnel Qualifications System
RGL	Reading Grade Level
ROC	Required Operations Capability
SFTOA	Systems and Feasibility Tradeoff Analyses (Phase I of NTIPP)
SIB	Ships Information Book
SIMM	Symbolic Integrated Maintenance Manual
SOP	Standard Operating Procedure
SSR	Ships Selected Records
SYSCOM	Systems Command (U.S. Navy; e.g., NAVSEA, NAVAIR, NAVELEX)
TAB	Training Aid Booklet
TM	Technical Manual

APPENDIX C
QUESTIONAIRE USED IN THE SURVEY

NAVAL TECHNICAL MANUAL QUESTIONNAIRE

We are changing the technical manual system to make it easier and better for you to use. We need your opinions to make the system work. In your answers you should say which manuals or which parts of manuals you need to do your job. You should also say which ones you don't need, and why. Your personal opinions are important. You can write on the back of the form if you want to.

We want to find out what works and what does not work. But more important, why the manuals work or do not work for you. We want to know what is good, what is bad, and why you feel that way.

In any answer to any question, give your opinion of what you think the cause of the problem is.

Your background and experience are important. But remember, you do not have to put your name on the form.

PERSONAL DATA:

Rate: Pay Grade: E-

Duty Station:

Your Job:

Are you: in school? ____, on OJT? ____, an operator? ____, a technician? ____, a supervisor? ____, an instructor? ____, other? _____
(Specify)

Years in the Navy:

Years on the Job:

Maintenance level you perform:

Organizational	____
Intermediate	____
Depot	____

Equipment you work on: _____

_____

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

"Description of Equipment" Section.

1. Is there TOO LITTLE, ENOUGH, or TOO MUCH technical description in the tech manual?

2. Is the technical level TOO SIMPLE, ABOUT RIGHT, or TOO HARD?

3 What about the writing? Is it understandable? Is it confusing? Is it TOO SIMPLE, ABOUT RIGHT, or TOO HARD?

4. Does this section of the manual seem clear and logical?

5 Is it complete and accurate?

6 How would you rather learn this information? By audio (like a tape recorder and earphones), or film and slides? Or a combination?

7. How much do you use this section for your work? (NEVER, SOMETIMES, MOST OF THE TIME.)

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

"Theory" Section.

1. Is there TOO LITTLE, ENOUGH, or TOO MUCH theory?

2. Is the technical level TOO SIMPLE, ABOUT RIGHT, or TOO HARD?

3. Does this section seem clear and logical?

4. Is the writing TOO SIMPLE, ABOUT RIGHT, or TOO HARD?

5. Are the diagrams accurate, easy to use, and easy to understand?

6. Instead of a printed book, would you rather have a different way of learning theory? How about film, slides, or tape and headphones?

7. How much do you use the theory section of a tech manual to do your job? (NEVER, SOMETIMES, MOST OF THE TIME.)

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

"Procedures" Section.

1. Are there TOO FEW, ENOUGH, or TOO MANY procedures?

2. Are the operating procedures TOO LONG, ABOUT RIGHT, or TOO SHORT?

3. Are the periodic maintenance procedures TOO LONG, ABOUT RIGHT, or TOO SHORT?

4. Are the troubleshooting procedures TOO LONG, ABOUT RIGHT, or TOO SHORT? Do you need them to do your job?

5. How would you improve this section? With more pictures, diagrams, and schematics maybe?

6. Do you have a place to put your manual while working?

   Do you have enough space?

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

"Procedures" Section. (Continued)

7. Are the pictures and diagrams clear? Is the printing big enough to read easily? Is the light good enough where you work?

8. Should waveforms, voltages, tolerances, torque values, pressures, temperatures, etc., be part of the procedures, all combined on one page, or both ways?

9. Should the procedures tell you how to use tools and test equipment in great detail, in a general way, or not at all?

10. What kind of troubleshooting procedures would you like to use? Step-by-step instructions? Tables with pictures and explanations? Flow charts? Other?

Why?

11. Should the procedures explain why each step is done?

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

"Procedures" Section. (Continued)

12. Do the procedures list all the tools, test equipment, and other things you need to do the job?

Is this important?

13. Is information about spare parts in the right place?

Where and how do you think it should be written?

14. How would you rather perform procedures such as alignment, checkout, and preventive maintenance? With an abbreviated checklist? Block diagrams? A schematic with input and output values such as voltage, tolerances, pressures, temperatures, and waveforms?

Do you use anything of this type in your job now?

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

General.

1. What parts of the tech manual do you use the least?

2. What parts of the tech manual do you use the most?

3. In your opinion, are there TOO FEW, ENOUGH, or TOO MANY diagrams, pictures, and drawings?

4. Which of these gives you the most information? (Photos, line drawing, blueprint, block diagrams, schematic or combinations.) List the ones you like best first.

5. Have you ever used a microfilm reader?

   If so, do you like this better than printed paper manuals?

   Would you like a mix of these two?

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

General. (Continued)

Which sections of the tech manual would you like to see printed?

Which sections of the tech manual would you like to see on microfilm?

6. Should the pages of the tech manual be plastic-coated?

Why?

7. Should some tech manuals be a different size?

Which ones?

8. Are the manuals too big?

Do you have trouble getting them to lie flat? Are the drawings too long?

General. (Continued)

9. Listed below are different sections of a tech manual. Each part can be presented in different ways, such as:

a. A printed book.

b. Microfilm with a viewer and a printer.

c. Audiovisual tape with a viewer.

d. A TV screen, with a typewriter keyboard so that you can ask questions.

e. Some other way?

We want to know how you would like to see the information presented. As an example, for Troubleshooting Procedures you may like microfilm best and a printed book as your second choice. So under Troubleshooting Procedures you would list "b", then "a".

Begin listing your choices.

Tech Manual Sections:

Description of Equipment -

Theory -

Operating Procedures -

Periodic Maintenance Procedures -

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

General. (Continued)

Troubleshooting Procedures -

Alignment Procedures -

Schematics, Diagrams, etc. -

10. Can you get manuals easily when you need them?

11. Are they located where you need them?

12. Are they kept up-to-date?

13. Do you write-up errors you find in the tech manuals?

If so, does anyone do anything about what you write?

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

General. (Continued)

How do you know?

14. Did you use tech manuals in your training course? Were you an instructor, or were you a student?

15. Did the instructor give you handout sheets?

16. What materials from your training course do you use on the job?

17. Have you added material or information of your own for use on the job?

If so, what did you add?

18. Do you have your own personal set of manuals and notes that you use on the job?

NAVAL TECHNICAL MANUAL QUESTIONNAIRE (Continued)

General. (Continued)

If so, what have you added or changed to make it easier for you to use?

19 Would you like to be given your own set of tech manuals at the beginning of training?

At the beginning of OJT?

What would be the advantages?

What would be the disadvantages?

Would changing pages and updating the manual bother you if you had to do all the updating?

20. Is it harder to use a manual that is classified Confidential or Secret?

General. (Continued)

Why?

21. In your opinion, how do the following subjects affect maintenance and your job?

Subjects:

Training programs -

Spare parts -

Technical manuals -

Tools and test equipment -

Other - (Use the back of this page if you need.)

APPENDIX D
QUESTIONNAIRE USED IN HUGHES FIELD ENGINEERING SURVEY OF SEPTEMBER/OCTOBER 1975

APPENDIX D

QUESTIONNAIRE USED IN HUGHES FIELD ENGINEERING SURVEY OF SEPTEMBER/OCTOBER 1975

NAME:
RATE:
DUTY STATION:
EQUIPMENT SPECIALTY:
YEARS IN NAVY:
TM OR TM CLASS BEING EVALUATED:

1. Do you feel that the Technical Manuals which you use are satisfactory in the following areas:

Adequacy of technical detail _____

- Is there enough technical information included to allow you to do your job?

Presentation Format _____

- Is the information presented in a logical/practical sequence?

Presentation Media _____

- Is the information presented in a useful, easy to access physical form?

Identification and Indexing _____

- Is there a simple means of identifying the correct TM volume or chapter for the job to be done?

Theory

- Is the theory adequate, clear, and of use? _____
- Is it too "text bookish"? _____
- Is it readable/comprehensible? _____
- Is there a better way to present theory? _____
- Are the diagrams usable, accurate, and complete? _____

Procedural Data

- Is it sufficient and clear or too "text bookish"? _____
- Are troubleshooting procedures needed/wanted? _____
- Do technicians want to know "why" as well as "what" and "how"? _____

2. Are Technical Manuals available for your use when needed? _____

   If not, why not?

   - Not available on station _____
   - Usually in use somewhere else _____
   - Other _____

3. Do your Technical Manuals accurately reflect the configuration of the equipment on which you work? _____

4. Are your Technical Manual Revisions current? _____

5. Which Technical Manual media would you prefer if given a choice? _____

	Theory	Alignment	Troubleshooting	Schematics
Hard Copy				
Microform				
Audio Visual (Video/Audio Tape)				
Interactive Display (Computer Aided Maintenance)				

6. Do you utilize feedback procedures when you detect Technical Manual deficiencies? _____

   If not, why not?

7. If you have submitted feedback data:

   Give your estimate of number of times submitted over what period of time. _____

   - Did you receive any acknowledgement of your input? _____
   - Did you receive any statement of proposed or actual action relating to your input? _____
   - Are you aware of any results directly attributable to your input? _____

8. How do you get TMs when you need an extra copy?

   - Is there a designated "library" point? _____
   - Do you use "Supply" as the source? _____

9. Did you use TMs in your training course? _____

   - To what extent (primary source or other) _____
   - Were they adequate? _____
   - Did the instructor prepare additional material as handouts? _____
   - Do you use the training material in your day to day activities? _____

10. Do you have your own personalized set of TMs or notes that you normally rely on to:

    - Repair the system? _____
    - Adjust the system? _____
    - Operate the system? _____

    If so, why is your data better than the issued TM? _____

11. In your opinion, which of the following general areas represent the greatest problem relating to effective equipment maintenance in the Navy today?

- Availability of tools and test equipment _____
- Identification and availability of spare parts _____
- Adequacy of Technical Manuals _____
- Effectiveness of personnel training programs _____
- Other _____